INDUSTRIAL ENGINEER

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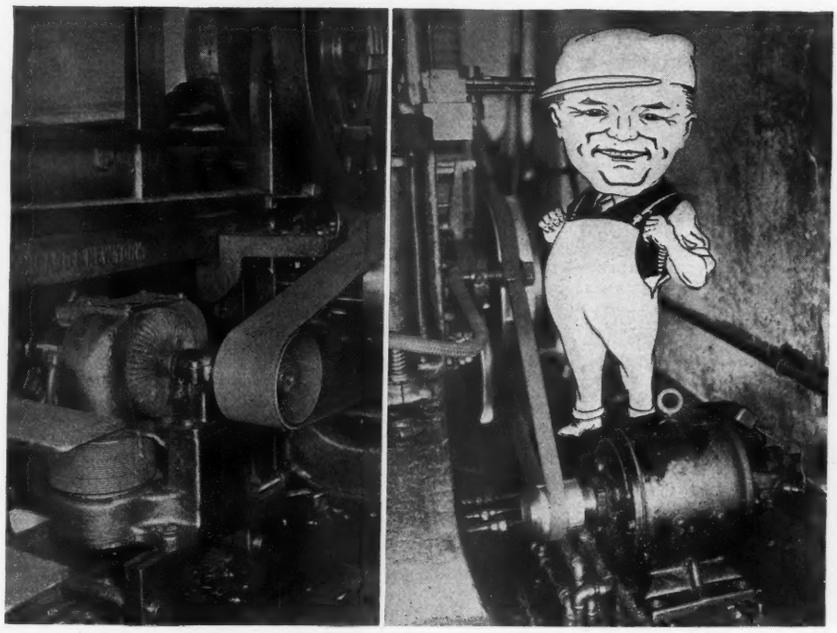
# Good Motor Service Is No Accident

## *It Represents a Combination of Cash and Horse Sense in the Original Guess on What The Motor Must Do*



A FEW weeks ago I was browsing around in some Chicago plants that have stood the test of time and competition, just looking for things that are or ought to be. And in the print shop of the Western Newspaper Union at 210 South Des Plaines Street, Chicago, the chief engineer (Mr. Steven Loughman) lead me by two motor drives that certainly got my attention and his apologies before he found out just why I was interested. When I told him I wanted to take pictures of the motors, he opened up and with some pride gave information that adds another interesting section to our series of references to good motors respected for long and satisfactory service records.

The photographs of these motors are shown here. On No. 1 the nameplate, which by the way is spread over the top in plain view and serves as something more than a decoration, read as follows: "Crocker-Wheeler, 5-hp., type 7½ c.c., No. 391, speed 600, volts 225, amps. 19.5." It's one of the old-time d.c. bipolars with ring-wound armature. Mr. Loughman told me that this motor was installed twenty-three years ago and has never been repaired so far as he knows. Furthermore, nothing else has ever been done to it except to replace the brushes and the last set was put on six years ago. This motor is now connected to a flat-bed press and operates 16 hours a day.

The nameplate on the motor shown in the other photograph read: "Robbins and Meyers, ¼-hp., patented shunt wound, speed 450, volts 230, amps. 1.3." Mr. Loughman said this motor was installed in 1901 and has a service record of no repairs beyond replacement of brushes. It is connected to a monotype caster and also operates 16 hours a day.

Here are two motors that the makers built better than they knew, with the same windings and the same commutators that have operated on a 220-volt, d.c. circuit for twenty-three years. And just now largely because we know more about insulation, dielectric strength of materials, hot-spot temperatures and the like, we hear a lot about what a motor will do or what it won't do when these technical points are on the floor for discussion. But all of the time these old fellows built by main strength and good judgment are breaking all the laws of theory and the prejudices of contenders for this or that technical point in construction.

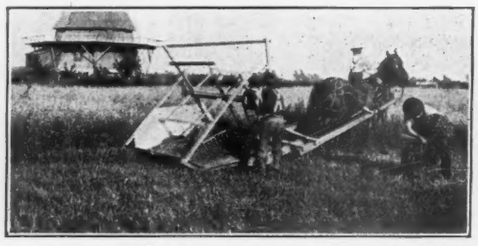
After all, the man who buys motors to use should expect a good and inexpensive service record, but in every case he has a responsibility further than paying the cost price. He must know what he expects a motor to do and remember always that a race horse hitched to a plow is a tragedy while a mule on a race track is a comedy, but to put each in its place of greatest usefulness, simply calls for a little judgment and a lot of horse-sense. Motors are now available that are just as good as the old timers ever were and perhaps a little better, but men in plants are often penny-wise and pound-foolish when they open their pocketbooks to buy them and they really buy a theoretical horsepower instead of service. Most people want good service with good food; that's the reason they give the waiter ten per cent or more of the actual price of the food they consume. But when it comes to consuming motors, we operating men seem hungry for poor quality and low price and then kick about the bad case of indigestion that goes with it.

Practical Pete

*A Glimpse Into the Works of*

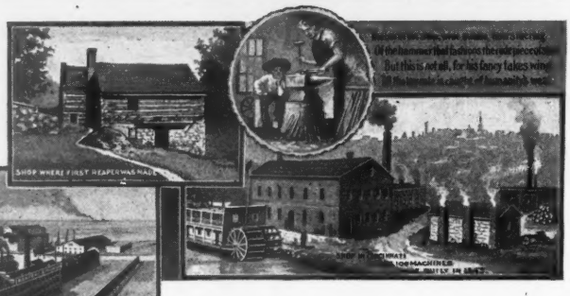
# The International Harvester Company

***And the divisions of its manufacturing activity engaged in the production of an extensive line of agricultural implements and farm machinery, the second of a series devoted to basic American industries.***



**The idea—reaping grain by machinery—and the manufacturing organization which has developed from it.**

Above are shown the three steps in the evolution of the harvesting of grain. When McCormick invented his reaper (middle view), grain was "cradled" by hand (left). In both instances it was bound by hand. At the right, two modern McCormick binders pulled by a tractor not only cut 25 to 35 acres a day but bind it into bundles and build six or eight bundles into a "shock," shown in the foreground which protects the grain. The pictures show the progress from 2 acres to 25 acres a day in harvesting methods. The first reaper was built in the blacksmith shop at the right in 1831. The first, but 100 machines were built in Cindevelopment of the industry was slow at cincinnati in 1845. The beginning of the present McCormick factory was laid in Chicago in 1847. When this was destroyed by fire in 1871, McCormick rebuilt on the South Branch of the Chicago River where the present plant shown by the bird's-eye view below stands. This plant is devoted to the manufacture of McCormick reaping and harvesting machinery, with the Tractor Works in the distance. The different divisions of this plant are as follows: (1) Works and engineering offices, assembling and finishing rooms; (2) Malleable iron foundry; (3) Grey iron foundry; (4) Paint and packing building; (5) Knife and grinding shop; (6) Bolt and nut shop; (7) Wheel shop; (8) Forge shop; (9) Wood shop; (10) Finished product warehouses; (11) Raw material yards; (12) Raw material sheds; (13) Twine mill; (14) Freight house; (15) Locomotive house; (16) Tempering shop; (17) Spring shop; (18) Paint grinding shop; (19) Chemical laboratory; (20) No. 5 warehouse transfer agency; (21) Hospital; (22) Fire and watch service station; (23) Garage; (24) Barn; (25) Motor truck shed; (26) and (27) Replacement parts shipment and storage; (28) Oil pumphouse; (29) Tractor works; (30) Clubhouse.




THE TRAIN of thinking between the development of an idea and the physical steps in production necessary to make it available to a wide field of usefulness is illustrated in a vivid way by the accomplishments of the International Harvester Company during the past 91 years. Every advance in the service of this all-American activity is evident to anyone who uses his eyes in travels through the agricultural sections of this country. Among nations agricultural resources are a measure of progress and commercial standing and upon it the structures of all other industries are built. Back of these resources of the United States of America stand examples of initiative and production methods that are equalled nowhere. And still back of these methods stand the machinery and tools of the agricultural industry that multiply the efforts of relatively few hands to proportions far beyond the dreams of those who saw the vision of the

possibilities that now are obvious.

Before Cyrus H. McCormick invented his reaper in 1831, most of the efforts of the farmer were required to supply food for his family. The surplus to feed those engaged in industry was relatively small. With practically no grain left over to trade, the farmer could buy but little.

Although this first reaper, operated by a man and a boy, cut 12 acres of grain a day in contrast to 2 acres a day by a man with a "cradle" (the grain had to be bound by hand in both cases) it was ten years before the first machine was sold, because of the prejudice against labor-saving machinery. Improvements in this reaper and new developments in other lines of agricultural machinery were rapid and in all of this activity the International Harvester Company has led with ideas and production expenditures to make them possible and permanent. Among the products now made by the Harvester Company, for instance, "P. and O." plows, date from 1842; Weber wagons, from 1845; Hoosier grain drills, from 1856; the Deering twine binder, which cuts the grain and binds it with twine, from 1879.

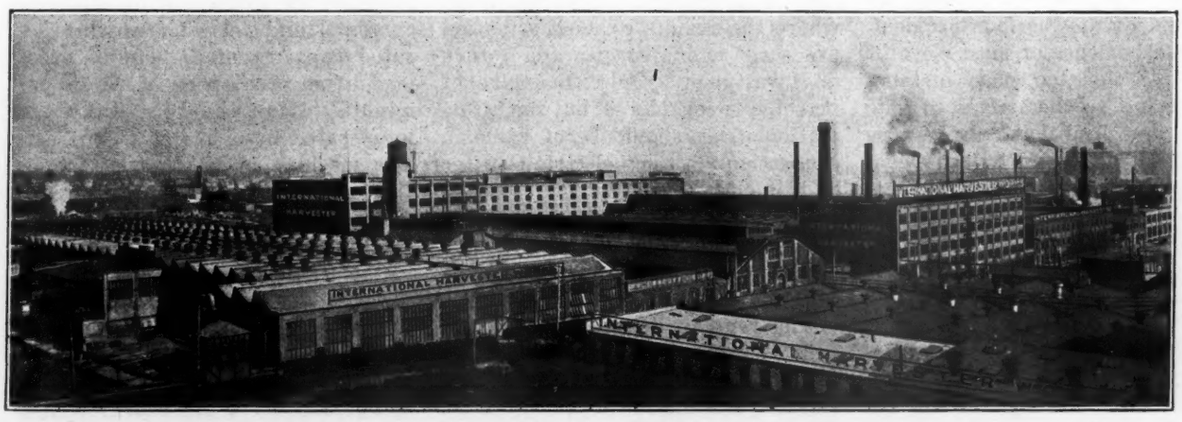
As a result of the perfection of machinery, the labor involved in raising a bushel of wheat has been reduced from 3 hr. and 40 min. to less than 10 minutes, a reduction of 95 per cent. Today 10 per cent of our population supplies food for the 90 per cent that are engaged in other industries and associated commercial activities.

**Sisal fiber going through the combing or preparing machines—one step in making binder twine, a product created by harvesting machinery.**

The work of the International Harvester Company in developing better agricultural machinery and better farming methods has reflected the scope of the service this equipment provides. The wide range of implements made for the most part of iron and steel call for a skill and production facilities that embrace all the mechanical arts. In the accompanying illustrations the diversity and scope of work done from a manufacturing standpoint and the facilities required are shown at a glance. From these works and others in this country and in Europe, the farmer can secure harvesting, haying and corn machines, tractors, gas engines, motor trucks, wagons, plows, cultivators and other tillage tools.

The factories of the International Harvester Company in the United States are widely scattered over the country, each specializing in a narrow field and making only a few types of implements. Several factories are in Canada. Chicago alone has the Deering and McCormick harvester plants and twine mills, the Weber wagon works, the Tractor works, and the West Pullman works.

**Tractors, gas engines and cream separators are made at the Milwaukee, Wis., works, one of the plants supplying the agricultural implement demands of the United States.**



**SERIOUS MISHAPS to passenger or freight elevators may result in loss of life or heavy damage to property, and even a minor failure may cause expensive interruptions of service. Proper inspection will detect trouble before it becomes serious. In this article Mr. Walsh outlines an inspection schedule for electrically driven elevators of the type used in industrial plants, and tells how to make the adjustments that are necessary.**

## *Details of Routine for*

# Electric Elevator Inspection

## *That Will Help to Protect Both Life and Property and Insure Continuity of Service*

By J. M. WALSH,
*Electrical Engineer, Gurney Elevator Company, New York*

*The inspector is shown here adjusting the brake on a freight elevator*

NINE-TENTHS of all elevator trouble results from lack of proper inspection and maintenance. Regular care and attention will go a long way toward averting minor mishaps, and will prevent the occurrence of any serious accident. It is the experience of most elevator service men that too many installations are left to themselves so long as they run. And it is only because every effort is exerted by the elevator manufacturer to make his machine as rugged and fool-proof as possible that this period of neglect can be quite prolonged before trouble develops. Given a machine and equipment of this character, why shouldn't proper inspection and upkeep pay good dividends in uninterrupted service and longer life of the installation? There is no reason why they won't, and the trouble and cost of such work is small in proportion to the benefits derived.

The inspection outline and maintenance hints herein described apply to the freight and passenger elevators in a modern industrial plant where the results of such attention are satisfactory service and return on investment. Only one make of machine is considered, but the information given should be of value in connection with any electric elevator of this class, for the same essential parts are to be found on all elevators, although the details of construction may vary somewhat in the different makes.

The regular inspection follows a definite schedule based on the order in which the different parts of the elevator installation are encountered. The schedule used divides the entire installation into five main parts, as follows: (1) The motor; (2) the machine; (3) the controller; (4) the sling and car, and (5) the hatchway or shaft appliances.

The first part of this article will describe the inspection of a direct-current freight elevator which has a rated capacity of 20,000 lb. gross load lifted at a speed of 25 ft. per minute. It serves three floors and is operated by a switch in the car. The machine is of the type known as V-groove or single-wrap traction; that is, the hoist ropes pass over the driving sheave only once, going then to the counterweight. The tractive force is applied to the hoist ropes through the V-shaped grooving on the traction sheave. The drive, from the motor, is through a single worm and gear enclosed in a cast-iron case. From the worm gear the drive is transmitted to the traction sheave

through a cast-steel pinion and cast-iron spur gear, both with cut teeth. The pinion is located on the shaft of the worm gear, while the spur gear is mounted on the same center casting as the traction sheave. The motor is plain shunt-wound, with interpoles. It is rated at 230 volts, 100 amp., for one hour at 50 deg. C. rise, and runs at 750 r.p.m.

The elevator machine is located in a roomy, well-lighted compartment in the basement. The car and counterweight, on account of the very heavy loads carried, are roped 2:1. That is, the hoisting ropes are not fastened directly to the car and counterweight, but pass around sheaves placed on top of both and then go to fixed anchorages on beams at the top of the shaft. This reduces the load lifted by the elevator machine to one-half what it would be with direct roping. The ropes travel twice as fast as the car and its load.

The entire installation, except as noted, is inspected weekly during operation, and necessary repairs are made on Saturday afternoons, or after quitting time on other days. This weekly, general inspection is sufficient because the service is not very severe in this particular case. Once a month the elevator machine is carefully examined for signs of wear and for necessary adjustments.

### Essential Divisions of an Elevator Inspection Schedule

**[1] THE ELEVATOR MOTOR**
Its lubrication; condition of bearings; brushes and commutator; evidences of winding troubles.

**[2] THE ELEVATOR WINDING MACHINE**
Its brakes, their operation and adjustment; worm gears and shaft bearings, their lubrication; bearing wear and adjustments; wear of rope grooves.

**[3] THE CONTROLLER**
Inspection of contactors and their adjustment; observation of condition and operation of carbon and copper contacts; bearings of contactor arms; examination of contactor coils and fusing of these circuits; thorough cleaning of controller.

**[4] THE SLING AND THE CAR**
Examination of the safety; its lubrication and testing.

**[5] THE HATCHWAY AND SHAFT APPLIANCES**
Condition of sheave which deflects ropes from traction sheave to counterweight; observation of condition of guide rails; cleaning of rails and inspection of guide shoes; condition of hatchway limit switch; condition of speed governor.

#### The Motor Is the First Part to Receive Attention

Starting with the motor, the inspector examines the oil well in the motor-bearing housing to see that it is kept filled to the proper level. He is careful not to overflow it, or allow the oil to get on the commutator. The well should not be filled while the motor is running; if oil overflows then, it is quite sure to get on the commutator. The oil ring is inspected to see that it is revolving freely. The oil is renewed every three months, all of the old oil being drained out and the well thoroughly flushed with lighter oil before refilling. A good grade of medium-weight machine oil is used and much care is taken to see that no dirt gets into the well, as a little dirt in the oil may cause serious bearing trouble. The inspector then tries the air gap with a feeler, preferably when the machine is not running. Under ordinary conditions bearing wear is not appreciable for a long time because of the relatively large air gap on this type of motor.

It may seem superfluous to say, "Don't oil the commutator," but the experience of most armature-repair men indicates the advisability of repeating this injunction. Oil, grease or lubricant of any sort is unnecessary on the commutator of most elevator motors, and its use will cause more trouble than it remedies. The motor on this elevator has flush mica and the brushes keep it worn down even with the copper, unless a hard spot shows up in the mica. This trouble is evidenced by a clicking noise as the high mica passes the brushes. A light application of an Ideal commutator dresser, fine grade, will remedy the trouble.

The inspector then examines the brushes for evidences of "copper picking," which ought not to happen, but occasionally does, and tests them for fit and pressure. Care is taken to see that the pressure finger bears evenly on the brush. About 1½ lb. pressure per brush is maintained on these brushes, which are ½ in. thick and 1½ in. wide. The brushes are not copper-plated, but pigtails carry the current to the brush arm. Copper-plated brushes, previously used, gave trouble when they wore down to the plating, causing arcing and burning at the commutator. The inspector cleans off any dirt that may have collected along the commutator edges of the brushes. He tightens the nuts holding the pigtail terminals to the brush arm, and also the screws holding the brush arms to the brush rocker.

A word of advice to over-ambitious inspectors: "Don't shift the brush rocker," if the motor is an interpole or commutating-pole type. The brushes were set in the proper position at the factory or on the job by the installers. To shift the brush rocker may cause faulty operation of the elevator and possibly a runaway. See that the set screw holding the brush rocker is kept tight. If the car speed seems to be uneven, look at the position of the mark on the brush rocker rim with reference to a similar mark on the end bracket. If the rocker happens to shift, accidentally, one way or the other, the car speed will be noticeably affected. In this event, shift the rocker back to make the two marks coincide.

When any electrical trouble develops it shows itself unmistakably. Grounds in the armature winding are the most frequent troubles. Removal of the armature is almost always necessary to effect proper repairs. About once a year the motor is "blown out" with an air hose or hand bellows, and the field coils and armature windings given a good coat of air-drying, finishing varnish.

#### Adjusting the Brake

After the motor, the brake is the next part of the elevator winding machine to be inspected. On most elevators the brake is of the spring-actuated type—that is, the pressure is applied to the brake pulley by the expanding force of a compressed spring, and is released by the pull of an electro-magnet against the spring pressure. The proper adjustment of the brake is a matter that is much neglected where regular inspections are not insisted upon, but it is a detail which, if attended to, will greatly improve the elevator service by rendering it easier to make good stops with the car. The brake on this machine is capable of three adjustments, namely: (1) Pressure on brake pulley; (2) stroke of magnet plunger, and (3) position of brake shoe relative to brake pulley. All of these adjustments are closely related and all affect the proper and efficient operation of the brake. The first adjustment is usually made by manipulation of a cap screw in the

brake lever, which screw bears against the spring. Such a screw is shown at *A* in Fig. 2. Turning this screw in against the spring will make the stops quicker on a given load, or will enable the brake to stop heavier loads. Turning it out lessens the pressure applied to the brake pulley, which means sliding with heavy loads. This adjustment should be made with the elevator car containing about the average load. The screw is turned in or out, as the case may be, until the stop is satisfactory; then the cap screw is secured in place by its lock nut. It is necessary to have the pressure the same on each brake shoe. This point may be checked by measuring the length of each spring from the shoulder on the machine to the spring cap on the outer end of the spring. Fig. 1 shows this procedure.

This adjustment being satisfactory, the inspector looks to see what effect it has had on the stroke of the magnet. In this machine the pull of the magnet becomes less the farther out the upper end of the brake lever is forced by the spring. It may happen that the force required of the magnet is so great that it will not draw in the plunger. In that event, the second adjustment is made by turning the magnet plunger (*P*, Fig. 2), first loosening the locking nut. The plunger is drilled for a spanner wrench, but the adjustment can be made as well with the fingers. The stroke of the plunger should not be more than 1/16 in. and not less than 1/32 in. for good operation. The length of the stroke is measured between the steel head of the plunger (*H* in Fig. 2) and the frame of the magnet. There is a leather washer between the head and the magnet frame, but this is disregarded in measuring the stroke. After this adjustment, the other plunger of the magnet is set so that both will act the same.

Next the inspector adjusts the position of the brake shoes. This is done with a small set screw (*D*, Fig. 2), located in the lever arm near its junction with the brake shoe. The shoe is hinged on the brake lever at *E*, and is pulled back against the brake lever by a small spring located at *F*. The set screw *D* serves as a stop for the brake shoe to rest against, and by turning the screw in or out the position of the shoe can be varied with respect to the surface of the pulley. If the screw is in too far the upper edge of the brake shoe will drag on the pulley; if it is out too far, the lower portion of the shoe will drag when the brake is applied. The weekly inspection, after the brake is once adjusted for satisfactory stops with average load, is to see that the brake shoes are not dragging. When it is found that one of them drags, prompt relief is given by manipulating the set screw *D* and locking it in position with its lock nut after getting the brake shoes clear. Two small oilers are provided in each brake shoe and its lever. These are filled weekly with medium-heavy machine oil. Sewed asbestos brake lining is used and is fastened to the cast-iron brake shoe with split copper rivets. It is necessary that the heads be countersunk well below the surface of the lining.

### Condition of Worm Gear Must Be Checked

The inspector next looks after the condition of the worm shaft and its bearings. Impending trouble from these is indicated by excessive end play, and the thrust bearing should be adjusted to reduce this. The adjustment of the thrust bearing is not necessary under ordinary conditions until the machine has been in service about two or three years. For an equal length of time after each readjustment, the thrust bearing should be all right. It sometimes happens, however, that the elevator will receive extra hard running or severe duty of some sort that will cause a chuck or knock to be heard when the machine is started and stopped. If the traction sheave is closely watched, it will be seen to rock back and forth as the machine stops. These are pretty good indications that the thrust needs attention. If the inspector thinks the end play is becoming too great he makes a test of the machine when the plant is shut down. The empty elevator car is run far enough above the top landing to bottom the counterweights, and the power is shut off the controller. The two brake levers are then encircled with a piece of stout rope and drawn together so that the brake shoes are released from the pulley. The car, being overbalanced, will remain stationary. The worm shaft is then turned by hand, using a winding-bar, which is a spanner wrench made to fit the motor coupling. On some machines this can be done by applying an ordinary monkey wrench to a squared projection on the end of the motor shaft which sticks out of the bearing housing. The worm shaft is turned until it sticks and the brake pulley is marked with reference to the upper edge of one of the brake shoes. Then the worm shaft is turned in the opposite direction until it again sticks, and the movement of the mark on the brake pulley is noted carefully. In a new machine this movement will be about 1/250 of a revolution, which is around ⅛ in. on a brake pulley 10 in. in diameter. This corresponds to about 0.010 in. actual end play of this particular worm shaft, and is about the maximum that should be allowed.

When it is found that the end play is greater than this, the inspector removes the bearing cap *A*, Fig. 3, from the rear worm-shaft bearing, which is, of course, the thrust bearing. Under the edge of this cap there are several paper gaskets or washers, and he removes one or two of these. Removing too many gaskets will make the thrust bearing bind, which would be followed by excessive heating and destruction of the entire thrust. The cap is then replaced and the cap screws holding it in position tightened to their seats. He then tries the worm shaft as before for end play, and removes more gaskets if the movement has not been reduced enough. When everything is satisfactory, and the worm shaft turns easily within the prescribed limits, the brake levers are released, and the machine operated.

**Fig. 1—Checking brake springs for equality of pressure.**
The length of this spring must be the same as that of the spring on the opposite side of the brake (not shown here).

The worm bearings and thrust are lubricated by the oil in the gear case, which will show a slight leakage through the gland or stuffing box of the bearing on the motor end of the worm shaft. This leakage should be caught in a small drip pan, and the inspector must see that it is emptied when full. If it is carefully strained, this oil may be returned to the gear case, but the practice is not advisable. It is just as cheap and safer to buy new oil.

In the cap which covers the thrust bearing there is a small hole closed with a pipe plug, shown in *A* of Fig. 3. If this plug is removed the inspector can determine whether the thrust bearing is getting proper lubrication from the oil in the gear case. Sometimes this bearing runs dry because the oil refuses to flow to it from the gear case. This occurs usually when the machine is first started up after an extended shut-down. When this condition is noticed, the bearing should be primed by pouring a small quantity of gear oil into it through this hole. The inspector must not forget to replace the pipe plug.

The worm gear and its shaft bearings, which include the bearing on the outboard side of the pinion, are next looked over. The condition of the worm gear can be observed through the handhole in the top of the case. Keeping the case properly filled with strained, heavy gear oil prevents excessive wear on the worm gear. The oil level should be maintained at the center of the worm shaft, as indicated by the overflow pipe in the side of the case. Fresh oil is added through the handhole from time to time. Once a year the elevator man removes all the oil, thoroughly cleans the case with light machine oil, and refills it with fresh, new gear oil. This operation, by the way, should also be performed about a month after the elevator is first installed. In too many installations the oil in the gear case is never inspected until the worm gear starts to wear out from lack of lubrication.

### The Worm Gear Shaft Bearings

The worm-gear shaft bearings are of the plain, babbitted, split type. The inspector should see that the grease cups are properly filled and that the grease is fed down to the shaft. When the bearing wears down noticeably, the upper half is removed and one or two shims taken out from between the two halves of the bearing. The upper half is then fitted to the shaft with a little scraping.

### Play of Worm Gear Shaft

The side play of the worm-gear shaft is closely watched on the monthly inspection. When it exceeds 1/64 in. it is time to take up the wear which has occurred on the steel washer *W*, shown in Fig. 6. There is another one of these washers on the worm-gear shaft, between the hub on the worm gear and the inside of the bearing. The washer shown is located between the outside of this bearing and the heavy cast-iron collar *C*. The collar moves along a Woodruff key on the shaft and bears against the washer *W*. The adjustment for side play is made by manipulation of the adjusting nut *N*, which fits on a thread on the shaft. The cap screws are removed and the nut tightened up until the end play is reduced to the practicable minimum. The adjustment should not make the washers bind, but should permit the worm gear to run easily. This nut and the thread upon which it moves, together with the collar *C*, form a combination which permits of adjustments for side play as fine as 1/360 in. The nut has six holes, equally spaced, and the collar ten, which gives thirty different positions in which two holes in each will line up so that the cap screws may be run through holes in the nut into the tapped holes in the collar. The thread is twelve per inch; so that each of the thirty positions will correspond to a movement of the nut and collar of 1/360 in. The wear on the washers is very slight—they need renewing about once in five years.

On the monthly overhauling the condition of the felt wipers on the inside of the gear case should be noted. These serve to prevent the oil from being splashed out of the gear case along the worm-gear shaft. They are easily renewed by removing the holding rings, which are secured with small cap screws.

The spur gearing requires the least attention on the part of the inspector. The teeth should be kept thoroughly lubricated with heavy grease and particular care taken to see that grit or dirt does not get into this grease, or on the gears. Care must be taken not to let the gear guards be bent or forced down on the gear or pinion.

The sheave-shaft, or main, bearings are of the same type as those on the worm-gear shaft. Shims are provided for wear and the bearings are kept well taken-up. On the weekly rounds the inspector examines the nuts on the bearing caps, for these will occasionally work loose. They should be kept tight.

The sheave itself is examined for excessive wear in the rope grooves. With proper loads on the ropes there should be little sheave wear after the first few months of operation. During this time it will be noticed that the ropes are wearing a seat for themselves in the V-grooving, but after this the grooves will acquire a smooth, glossy finish.

Most freight elevators are single-speed and the control equipment is quite simple. The wiring diagram, secured from the elevator manufacturer, is mounted on a thin piece of sheet iron and painted with clear shellac. It is hung on the wall near the controller, available at all times to help in tracing out trouble with the operating circuits. Intelligent study of the wiring diagram by the man in charge of the elevator installation is well repaid by the ease with which such study enables him to locate circuit trouble.

### Weekly Inspection of Control Equipment

On his weekly inspection trip the elevator man observes, first of all, the operation of the various contactors. He notices whether they, particularly the armature contactors, are closing and opening in the proper sequence. From the diagram the proper order of closing is learned. If observation shows that, for example, contactor No. 2 is closing ahead of No. 1, the inspector proceeds to remedy the trouble. On some contactors a small cap screw with a locking nut on it is located under the tail-piece of the contactor arm. Loosening the locking nut permits the cap screw to be adjusted in or out, thereby varying the air gap between the arm and the core of the magnet. The gap is adjusted until the contactor closes in its proper order, whereupon the locking nut is firmly tightened. The chief cause of gap variation comes from loosening of this nut; so the inspector must look at these regularly every week.

The condition of the copper and carbon contacts next claims the attention of the inspector. The copper contacts are cleaned off carefully with sandpaper or emery cloth when-

ever they show any signs of pitting or burning. The inspector is careful to remove all beading which may form on the face of the contact. When pitting or burning has worn the contact down thin, it should be renewed before the fiber bushing in the contactor arm is damaged. The gap between the carbon and the copper contact surfaces should be noted and efforts made to keep this constant by adjustment of the carbon contact in its holder. The surface of the carbon should be kept clear of the copper holder. Most controller troubles come from carelessness in allowing the carbon contacts to burn and wear away until the copper contact strikes the carbon-contact holder.

The pressure between the carbon and the copper contacts must be watched, too, because the current-carrying capacity of the contactor depends on this pressure being maintained at its original value. On the panel of the elevator under discussion a pressure of about 2½ lb. on each small contact and 5 lb. on the large contacts is about right, and the inspector checks this with a small spring balance. To do this, the main-line switch is opened and the contactor to be tested is held in its closed position by hand. A small loop of wire or string, fastened to the nut and stud on the contactor, is engaged with the hook of the balance and the reading noted when a direct pull on the balance causes the copper contact just to leave the carbon contact. When everything else is right, but the pressure is still low, the compression springs on the copper contact should be examined for temper. After long service these sometimes lose their temper—especially if the copper contacts have been allowed to wear down too thin. When it is found that the springs are weak, they are replaced with new ones, which can be obtained from the manufacturer.

The nuts on the terminal studs and contacts are examined by the inspector to see that they are tight. A loose nut on a contact will cause arcing between the terminal of the connecting cable and the contact stud, with bad results to both.

The bearings of the contactor arms are given a drop or so of machine oil on the weekly inspection trip. This serves to prevent any sticking of the contactor and insures long life to the bearing pins.

The entire controller, front and back, is carefully cleaned on the monthly overhaul; so that dirt has

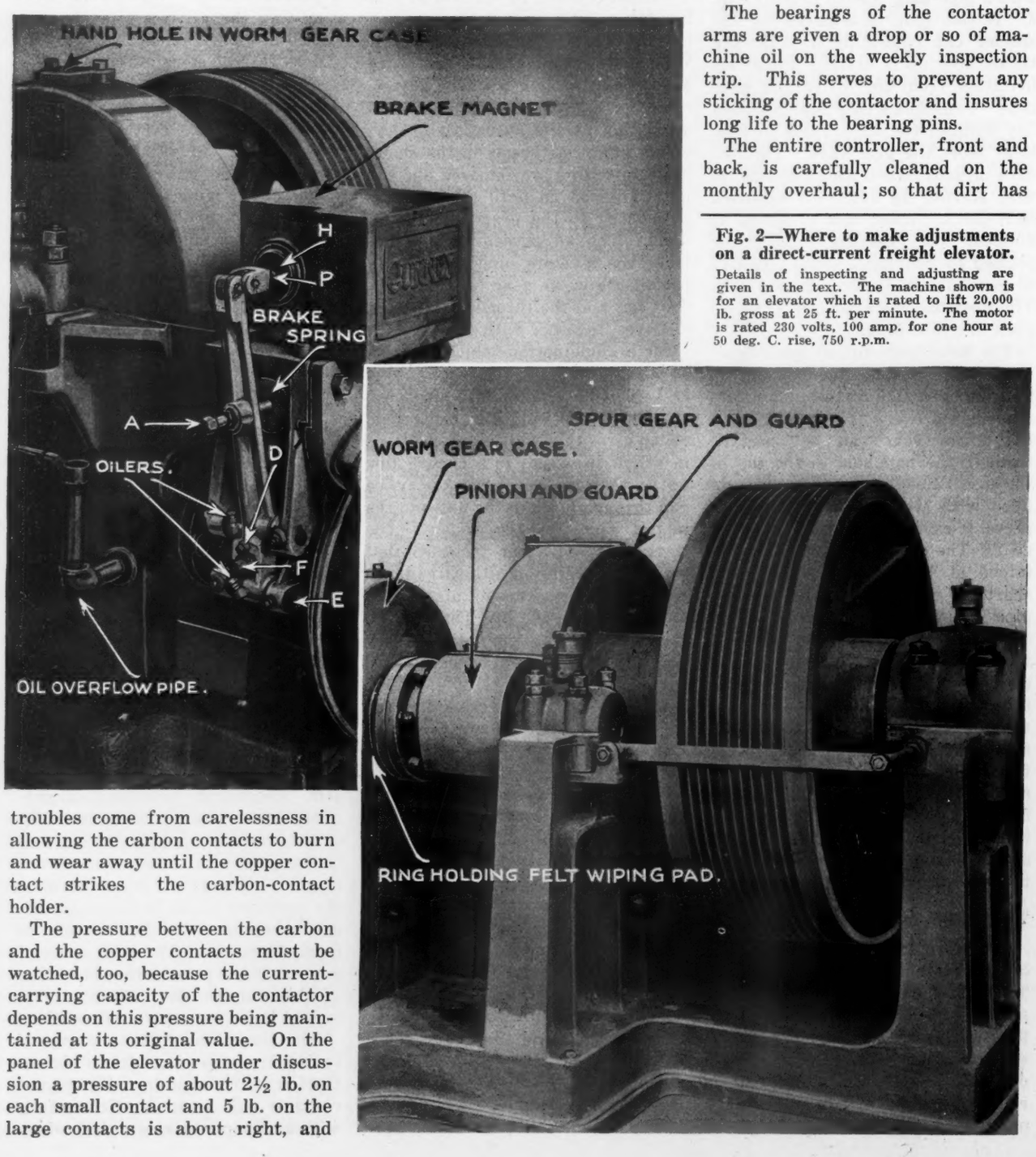



**Fig. 2—Where to make adjustments on a direct-current freight elevator.**

Details of inspecting and adjusting are given in the text. The machine shown is for an elevator which is rated to lift 20,000 lb. gross at 25 ft. per minute. The motor is rated 230 volts, 100 amp. for one hour at 50 deg. C. rise, 750 r.p.m.

**Fig. 4—A form which helps the elevator inspector to remember.**
It also serves to keep the superintendent informed of the condition of the machines.

**MONTHLY INSPECTION REPORT ON ELEVATORS**

DATE _____ 192__ INSPECTION MADE BY _____

Examine all parts of elevators and if found in good condition, place a check (✓) in space allotted under each item. If not in good condition, use a cross (X) and note defects under "Remarks"

| ELEVATOR NO. | MACHINE | BRAKE | MOTOR | CONTROLLER | BELTS | CAR | ENGINES | CAR CABLES | COUNT CABLES | COUNTER CABLES | SHAFT | GUIDES | PIT | GATES | DOORS | SWITCHES | LOCKS | SAFETY DEVICES | BELLS | CORDS | WIRING | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | |
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no chance to collect and cause short-circuits or grounds. Care is taken to see that no metallic objects are placed on top of the resistance grids. On the monthly cleaning, all nuts on the back of the board are examined to insure their being tight.

Contactor coils give little trouble from burn-outs, but when one does fail it is easily and quickly replaced with the "spare" always kept on hand. In case the burn-out occurs on one of the armature contactors and no spare is available, the damaged coil may be bridged and operation continued. This is only a temporary expedient, however, as the other contactor coils will heat much more than under ordinary conditions. Bridging should be resorted to only in case of urgent necessity. Burn-out of the coil on the dynamic-brake contactor need not interfere seriously with the operation of the machine beyond rendering the stops harder to make, due to the absence of full dynamic braking. It is not necessary to bridge this contactor coil in case of burn-out, but it should be replaced as soon as possible, in order to have satisfactory car stops. A burn-out of the field contactor will cause the car to run at low speed and the field coils of the motor to heat up abnormally, if the operation of the car continues. For emergency work this is tolerated, of course, but the defective coil is always replaced as soon as possible. Main-line contactor coils must always be replaced before operation is attempted.

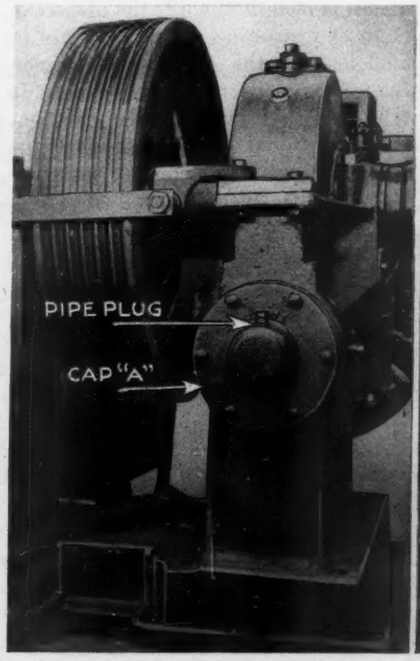
In replacing the baby fuses on coils care is taken to use fuses of no higher rating than those originally furnished with the controller. Contactor-coil troubles are mostly due to fusing these circuits too high.

## Keeping the Sling and the Car in Condition

Leaving the machine room, the inspector goes to the elevator car. He is concerned here with the car switch which controls the operation of the machine. If it is working well and everything appears to be in good condition, it is passed on the weekly inspection trip. Once a month the cover is removed and the condition of the contacts observed. If pitted or burned, they are sanded smooth and cleaned. A little oil is placed on the bearing of the switch arm, and any dirt that may have collected in the case is removed.

The inspection of the sling means chiefly the examination of the "safety." This is located underneath the car platform, and is best inspected from the pit, see Fig. 5. Once a month is often enough to look it over. The car is lowered so that the inspector can easily examine all working parts of the device while standing in the pit or on a plank over the hatchway at the first floor. This safety is of the clamp type, wherein two steel jaws clamp the rails. These jaws are actuated by wedge-shaped nuts within which turns a threaded shaft revolved by the unrolling of the tail-rope from a drum fastened on it. The various moving parts are greased and their condition observed. The guide shoes on the car are also examined at this time. The shoes on the bottom of the car require special attention because the side play of the car, due to wear on the sides of this set of shoes, must not become sufficient to permit the jaws of the safety to come in contact with the guide rails. This condition would result in wear taking place on the surface of these jaws, or in the jaws cutting the rails. The shoes are of cast iron, fitted with renewable cast-iron gibs. These gibs are renewed as soon as they become so worn that there is a possibility of the safety jaws touching the rails.

Attached to the safety plank is a simple switch enclosed in a metal box (shown in Fig. 5) which serves to stop the elevator machine when the safety is applied. It is actuated mechanically by the safety. When



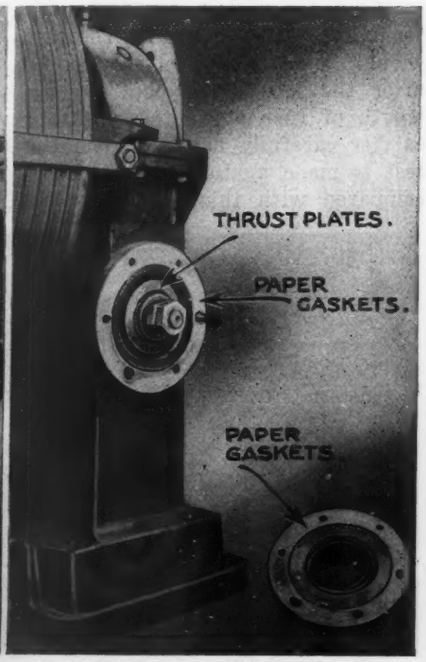




**Fig. 3—End play of worm shaft is adjusted by means of paper gaskets.**
This is the thrust bearing of the worm shaft. Cap *A* is removed and then the paper gaskets are put in or taken out. The worm should have about 0.010 in. end play.

**Fig. 6—Adjustment is made here for side play of worm gear.**
The nut *N* bears against the collar *C*, which slides on the shaft but is keyed to it. The collar presses against a washer, *W*, which rests on the bearing. The two cap screws are employed to lock the nut to the collar. In Fig. 8 this nut is shown in place.

the latter is inspected the cover is removed from this box and the operation of the switch tested. Beyond keeping it clean and the bearing parts oiled, it requires no attention.

The safety is tested about once every six months—oftener if it is called into use very frequently. One of the handiest ways of making this test is to get on top of car and lift the governor clutch from the releasing carrier by means of a spring finger which permits it to slip out when the governor rope is pulled upward. The amount of tail rope run off is an indication of the condition of the jaws, rolls and wedges of the safety. It should be known how much tail rope was run off when the safety was first tested. If this information is not available, the test should be made as soon as possible after the job is installed and the length of rope above the releasing carrier carefully noted. When the test is made again the results are compared with this figure. When the two readings differ greatly, the chances are that the jaws are worn enough to warrant the installation of new ones.

It may be well to say a word about rewinding the tail rope on the safety drum after the above test, or, for that matter, after any occasion when the safety has been applied. To do this properly requires two men, one in the car to manipulate the wrench which rotates the safety drum and one under the car to guide the rope properly into the grooving on the drum. After releasing the safety by means of the wrench, the car should be run to the lower floor, where a man in the pit or standing on a plank across the hatchway at the first floor can reach the safety drum. Then, as the man in the car rotates the safety drum, the second man carefully guides the tail rope into the grooving on the drum. Unless this is done the rope is very likely to wind unevenly and pile up so that the next time the safety is called upon to act there is danger of the rope binding and possibly breaking before the safety jaw can grip.

### Hatchway Appliances Are the Most Likely to Be Neglected

The inspector comes now to the hatchway, and it is here that the parts of the installation are most likely to be neglected. This is because of the comparative inaccessibility of these parts and also because of a lack of knowledge as to what and where they are. The cables are included in this part of the inspection schedule. Their general condition is observed while the inspector is in the machine room, and this is sufficient if the elevator insurance inspections are regularly made. It is found that by following the recommendations of the insurance inspector as to rope renewal, satisfactory cable service is obtained.

**Fig. 5—The "safety" should be inspected monthly.**
This picture shows the bottom of the elevator car with the various parts of the safety equipment.

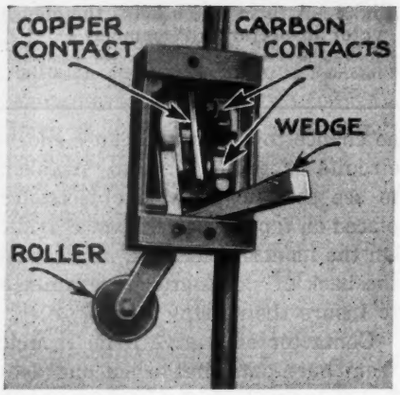



**Fig. 7—How contacts of hatchway limit switch are examined.**
A wedge is used to hold the contacts open while they are being inspected and adjusted.

The sheave which deflects the ropes leading from the traction sheave to the counterweight is fastened to the ceiling beams of the machine room. The grease cups on this sheave are kept filled and a turn or two given the cups on the weekly inspection. Wear on the moving parts of this sheave is found to be slight if the lubrication is properly attended to.

The inspector now gets on top of the car and sees to the condition of the sheave located there. The grease cups on this sheave are carefully looked after because the heavy loads on the shaft of the sheave will cause rapid wear if the lubrication is neglected. They are carefully cleaned all over once a month.

The car is now operated by an assistant, the inspector remaining on top to observe the condition of the rails as the car proceeds up the hatchway. Dirty, gritty guide rails mean increased friction with resultant increased power consumption. Where there is much dust in the air, or where the hatchway is used as a convenient dirt chute, the greasy rails will collect enough dirt to make an appreciable difference in the power bill. When such conditions are found, the man in charge of the machine cleans the rails with kerosene and rags—waste has a tendency to stick to the rails. After cleaning, the rails are re-oiled. Local conditions govern the frequency with which cleaning is needed, but a careful inspector will know when it should be done. The counterweight guide

rails do not require such careful attention, as there is more play between them and the slots in the weights, and little or no side strain.

The guide shoes on top of the car are examined at this time. Like the lower guide shoes, they have renewable gibs, which in this set are renewed when the play between the rail and the gib of the shoe is more than 1/32 in.

The car is stopped in its upward journey when the sheave on the counterweight comes opposite the inspector. The same careful attention is given to this sheave as to the one on top of the car.

As the car nears the upper limit of travel the inspector prepares to note the condition of the hatchway limit switch which is fastened to one side of the shaft. This switch stops the car if the operator runs beyond the final landing. Fig. 7 shows this switch with the cover removed. A similar switch is located near the bottom of the shaft. These switches are actuated by an angle-iron cam attached to the side of the car, and the inspector satisfies himself that this cam is firmly in place. On the monthly inspection the cover is removed from the hatchway limit switch and the contacts cleaned and adjusted the same as the copper and carbon contacts on the controller. A drop or two of oil is applied to the moving parts.

The inspector gets off the top of the car at the upper landing and goes to the pent house. Here are located the overhead sheaves and the speed governor. There are two overhead sheaves on this installation. They are lubricated with grease cups which are kept properly filled, and the grease fed down to the bearing. Any dirt collecting around them is carefully cleaned away.

The speed governor, if of a simple type, requires attention only to the grease cup located in its fixed shaft. When this is kept filled and properly adjusted the governor gives no trouble, if dirt and grit are kept away from it. The condition of the governor cable is observed at this time. Unless the safety is applied through the action of the governor, the wear on the rope is very little.

For an alternating-current elevator or a passenger elevator, the care is about the same as that already described for a direct-current freight elevator. With the alternating-current system the maintenance is slightly different with regard to the motor, brakes and controller. A passenger elevator differs from a freight elevator chiefly in the construction of the sling and of the winding machine.

### Care of Alternating-Current Passenger Elevator

The elevator which will be particularly described is located in a factory and serves four floors. It is rated to lift 2,500 lb. gross load at a car speed of 100 ft. per minute and is driven by a squirrel-cage induction motor. The motor is rated at 230 volts, 10 hp. for 30 minutes at 50 deg. C. rise. It is wound for two-phase, 60 cycles, and runs at a full-load speed of 960 r.p.m. (synchronous speed, 1200 r.p.m.).

Unlike the freight elevator previously described, this machine is located in a pent house directly over the top of the hatchway or shaft and is roped directly to the car instead of employing the 2:1 roping arrangement, as on the freight machine. It is, however, of the same type as the freight elevator, namely, V-groove or single-wrap traction, but the drive is made from the motor directly through the worm and worm gear to the traction sheave without any spur gearing coming in between as in the case of the other. The driving or traction sheave is on the same shaft as the worm gear, both being bolted to the same cast-iron center.

The operation of the elevator is controlled by a car switch the same as the freight elevator. The whole equipment, excepting the car safety and the hatchway appliances, is inspected weekly and once a month everything gets a thorough looking over for necessary adjustments and cleaning. The same schedule is followed as was outlined for the freight elevator, and the adjustments and tests described apply to this machine except as noted under the corresponding headings below.

### Care of Alternating-Current Elevator Motor

Starting at the motor, the inspector, knowing that the troubles most likely to occur are the result of worn bearings, looks first to see that the lubrication of the two motor bearings is being properly accomplished. The oil well is kept filled to the proper level and care taken to see that the oil ring is revolving freely. There is the greatest need for keeping the oil free from grit or dirt. A hot bearing, with possible stalling of the motor, is one result of grit in the oil. Once every three months the oil well is drained out, cleaned with new, light oil and refilled with clean, fresh oil of medium consistency.

Next the inspector tries the air gap, using the gage supplied with the motor. When the gage refuses to enter freely between the rotor and the stator, it is time to renew the bearings. The gap should be tested in at least four places about equally spaced around the rotor, paying particular attention to the gap at the lower half. If the motor stalls while in operation it may be found that the rotor has been rubbing against the stator so much that the friction has been greater than the pull-out torque of the motor. When this happens the motor hums loudly and excessive current flows until the fuses blow.

On the monthly inspection the condition of the rotor rings should be examined. If the motor has been stalled very often there may be a tendency for the end rings to become loose or otherwise out of condition. Once a year the stator windings are thoroughly cleaned out with an air hose or a common hand bellows, after which they are given a coat of black, oil-proof, air-drying varnish.

Sometimes it happens that the motor refuses to start when the car switch is manipulated. The motor howls and the fuses blow. This state of affairs is usually the result of low line voltage. The torque or turning power of an induction motor varies directly as the square of the voltage at the motor terminals. When this voltage falls off by any appreciable amount the torque which the motor is able to exert may not be sufficient to start the elevator. The remedy for this condition is, of course, larger transformers and supply lines or better regulation of voltage by the power company. If the motor gets low voltage very frequently, there is danger of burning out the windings. When the voltage is normal and there is nothing wrong mechanically, but the motor refuses to start, an open circuit in the windings is to be looked for.

### Setting Alternating-Current Brakes

The adjustment of the brake and brake shoes is the same as on the direct-current machine, with the exception of the adjustment for stroke of magnet. This is made by manipulating eye-bolt *C*, shown in Fig. 8. The locking nut is loosened, the bearing-pin *P* removed and, by means

of the threaded eye-bolt, the armature of the magnet moved closer to the poles until it is snapped up satisfactorily when the car switch is operated. The other armature is adjusted the same as this one; so that they will act alike. When the adjustment is satisfactory the eye-bolt is locked with the locking nut and the cotter pins are properly replaced in the bearing pin *P*. If the atmosphere is inclined to be dusty or dirty, the cover of the brake magnet should be removed about every two or three weeks and the contact faces of the armature and magnet carefully cleaned, so as to insure quiet operation.

### Care of Alternating-Current Control Board

What was said about contact pressure for the direct-current panel and so on holds good for this controller also, as the construction of the contactors is similar. In addition, however, there is the necessity of keeping the contact faces of the magnets and armatures clean and free from grease and dirt. This is to insure quiet operation of the contactors. The presence of dirt or grit on the surface of the magnet or armature will cause the contactor to hum when it is closed. The blow of the contactor arm at the moment of seating is eased by an air dash-pot which is attached to the back of the control panel. The dash-pot needs no attention from the inspector, beyond keeping the valve opening clear of dirt and the piston rod slightly oiled.

The inspector after seeing that the nuts on the contact studs are tight, looks at the phase-failure and phase-reversal relay. This is enclosed in a cast-iron box located near the top of the control panel. The purpose of this relay, as its name indicates, is to prevent the operation of the motor on less than the proper number of phases, or when the phases are reversed in their relation to each other. The inspector on his weekly trips removes the cover and examines the contacts of the relay. Because of the comparatively light pressure between the two contact surfaces in this device, they must be kept very clean and free from dirt; failure to make proper contact will render the car inoperative because the operating circuit is made through this relay.

In case of a burn-out of either of the line-contactor coils a new coil must be inserted before operation of the car can be resumed. If one or more of the phase-relay coils burns out, the two upper terminals of the relay may be tied together in order to permit operation of the car. But it must be remembered that this action removes the protective features of the relay and that, consequently, operation under these conditions must be very carefully watched.

The back of the control panel is inspected for loose nuts or wires, and the whole thoroughly cleaned once a month.

### Guide Shoes of Passenger Car

Inspection and tests of the safety apparatus on the car are carried out as for the freight elevator. The guide shoes, however, are a different type. They are solid cast-iron without gibs, are set in holders and are self-adjusting, for a certain amount of wear, by means of a compression spring located in the socket of the holder. When worn so that the car has too much side play they are adjusted by loosening a set screw which holds the spring stop in the socket and driving the stop forward enough to make the spring again hold the shoe up to the rail. They are renewed when they become so worn that there is more than 1/32 in. between the side of the rail and the guide shoe. There is, of course, no sheave on the top of the car, since the ropes are attached directly to the car sling.

While the many adjustments and repairs which may become necessary have been discussed in detail, it must be remembered that it is not necessary to perform each one of them every time the inspector examines the equipment. Even on the monthly overhauling it may not be necessary to dissect the thrust bearing or to test the safety. It is well to bear in mind that too much tinkering and adjusting is as bad as too little.

Cleanliness is the first requisite for maintaining safe, efficient and economical operation of the elevator. Next to this is proper lubrication. Regularly and intelligently attended to, using clean oils and greases, it lengthens greatly the life of the equipment. If these two items are given the attention they deserve the repair work and the cost of replacement will be small.

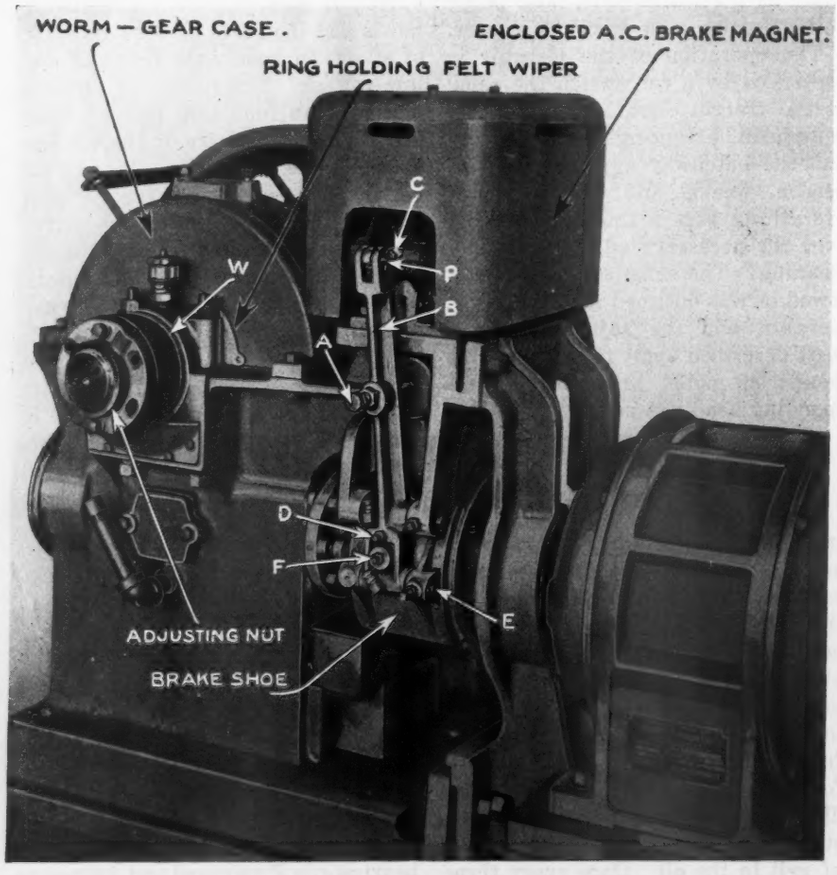



**Fig. 8—This shows where adjustments are made on alternating-current elevator machine.**

This machine is for a passenger elevator rated at 2,500 lb. gross load, 100 ft. per minute. The squirrel-cage motor is rated 10 hp. for 30 min. at 50 deg. C. rise, 230 volts, two phases, 60 cycles, 960 r.p.m.

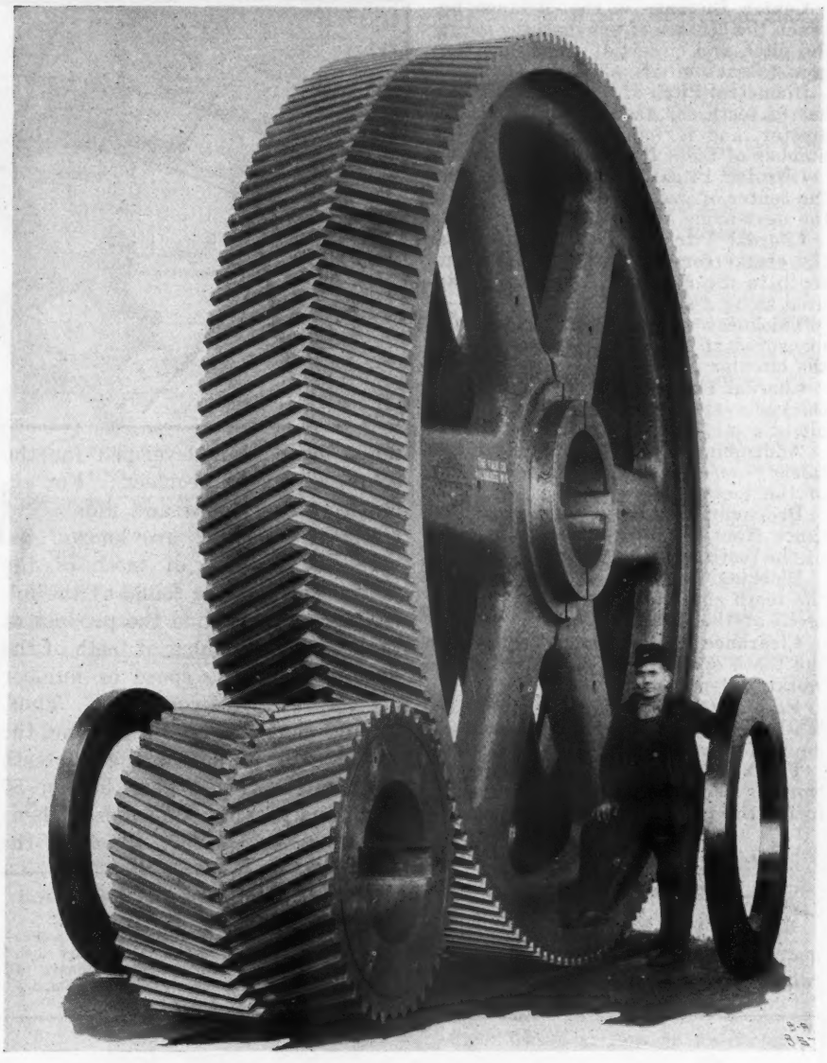
**GEARING PLAYS a prominent part not only in the design of the majority of machines, but in the transmission of power from motors or other prime movers to the machines which they operate. In this and a succeeding article the salient characteristics of the various kinds of gears are discussed, and information given which should be known to everyone who has to solve gear problems and make the decisions involved in the use of such equipment.**

*Some Pointers on the*

# Use of Gears and Pinions

## *That Will Help the User to Select and Apply Them to the Best Advantage*

By G. A. VAN BRUNT,
*Managing Editor, Industrial Engineer*



*This is a herringbone gear and pinion for reducing speed from 110 r.p.m. to 30 r.p.m. between engine and hot rolling mill. At peak load 7,000 hp. is transmitted.*

GEARS and pinions provide a simple and usually efficient means of transmitting power at a constant speed ratio and are among the most widely used of mechanical devices. Transmission of power may be between shafts on the same or different planes, and the speed of rotation of the driven shaft may, as desired, be greater, the same as, or less than that of the driving shaft. In order to meet the various conditions encountered and render the service required, several distinct types or classes of gears have been developed and are in wide use. A rough but convenient way of classifying gears is based on the service which they perform, as follows: (1) Gears connecting parallel shafts. This includes spur, helical, herringbone and internal gears. (2) Gears connecting at any angle shafts in the same plane. Bevel gears fall in this class. (3) Gears connecting at any angle shafts not in the same plane. This class embraces worm, spiral and skew bevel gears.

*Spur Gears* are the simplest form of toothed wheel, with the teeth parallel to the axis. The fundamental shape of the teeth and the accuracy with which they are formed determine whether the operation of the gears will be smooth, efficient and noiseless or whether the movement of the driven gear will be made up of alternate accelerations and retardations which will not only absorb a large amount of power, but tend to disintegrate the material of which the gear is constructed. Various forms of teeth have been proposed and used to some extent, but what is known as the involute form is now employed almost exclusively. Although this is a subject which is of more interest to the designer than to the user of spur gears, it may be said that an involute curve is generated by rolling a straight line on a circle; any point on this line then describes an involute. It is also described by unwinding a string from a circle.

In order to have a clear understanding of the terms used in describing and in making calculations for gears, the following definitions should be kept in mind:

**Pitch Diameters and Pitch Circles**—If two circular disks are in contact, so that when one disk is revolved it will drive the other disk by frictional force, the diameters of the disks are then the same as the pitch diameters of corresponding gears, and the circumference of these disks, which are tangent to or touch each other, represent the pitch circles of the gears.

**Outside Diameter** of a gear is the diameter measured over tops of teeth.

**Root Diameter** of a gear is the diameter measured at the bottom or roots of the teeth.

**Center Distance** is the distance between the centers of two meshing gears, the pitch and circles of which are tangent to each other.

**Diametral Pitch** of a gear is the number of teeth for each inch of pitch diameter, and is found by dividing the number of teeth by the pitch diameter.

**Circular Pitch** is the distance from the center of one tooth to the center of the next along the pitch circle.

**Chordal Pitch** is the distance from the center (or the pitch circle) of one tooth to the center of the next, measured along a straight line.

**Thickness of the Tooth** is generally measured at the pitch circle and along the circular arc.

**Chordal Thickness of the Tooth** is the thickness at the pitch circle measured along a straight line or chord.

**Addendum of Gear Tooth** is the distance from the pitch circle to the top of the tooth.

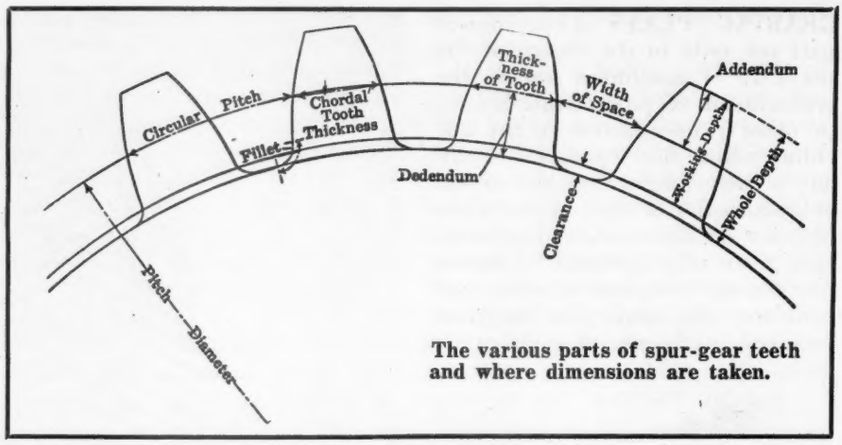
**Dedendum of a Gear Tooth** is the distance from the pitch circle to the root of the tooth.

**Working Depth** is the depth to which the teeth enter the spaces between the teeth of the meshing gear.

**Clearance** is the amount by which the tooth space is cut deeper than the working depth.

**Face of the Tooth** is that part of the tooth curve that is between the outside circumference and the pitch circle.

**Flank of the Tooth** is that part of the working depth of the tooth which comes inside the pitch circle.

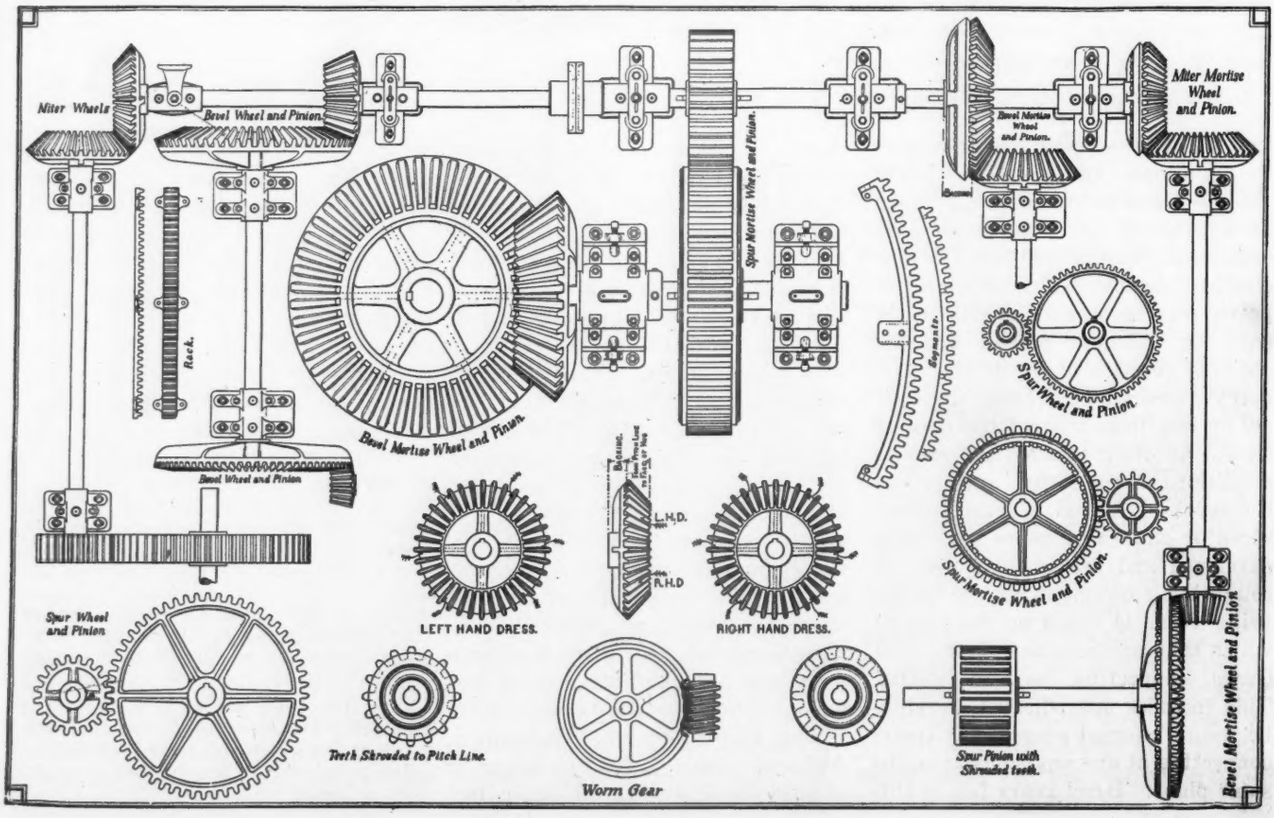



**The various parts of spur-gear teeth and where dimensions are taken.**

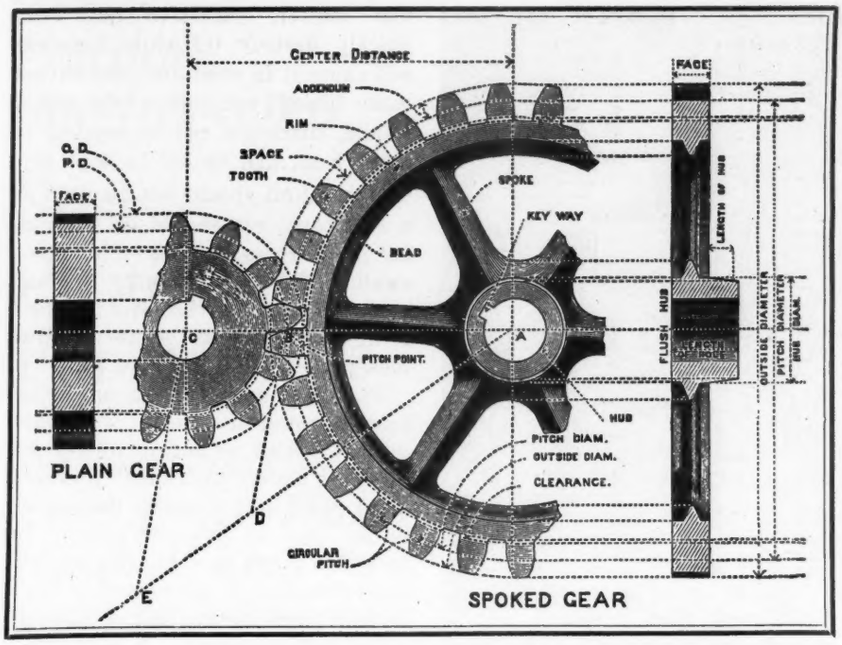
## Calculations for Speed and Power of Gears

Among the problems which the user of gears must solve are those relating to the speed. Simple formulas have been developed for the solution of such problems. For example, if the speed and number of teeth of one gear are known, the speed or number of teeth of the mating gear can be found by the following rule: Divide the product of the speed and number of teeth of the first gear by the speed or number of teeth of the second gear. Thus, assume that it is required to find the r.p.m. of a pinion having 20 teeth and mated with a gear having 80 teeth and turning 300 r.p.m.. Then: $(80\times300)\div20=1200$, which is the speed of the pinion. Or, if it were desired to find the number of teeth in a pinion to be mated with the above gear so that the speed of the pinion should be 1200 r.p.m.: $(80\times300)\div1200=20$, or required number of teeth in the pinion.

The same procedure is followed when dealing with a train of gears; that is, the continued product of the pinions and the continued product of the gears is used in the same way as for a single pinion and gear. For example, assume a train of gears, A, B and C, with pinions a, b and c. Gear A has 100 teeth, B 70 teeth and C 60 teeth. Pinion a has 15 teeth, b 18 teeth and c 24 teeth. Gear A has a speed of 10 r.p.m.. What is the speed of pinion c? The teeth of




**Diagrammatic view of the several kinds of gears.**
This illustration shows the shape and working relation of the gears in ordinary use. It is reproduced with acknowledgments to Christiana Machine Co., Christiana, Pa.




**How the parts of a spur gear and pinion are designated.**
This illustration is reproduced with acknowledgements to Philadelphia Gear Works, Philadelphia, Pa.

gears A×B×C=100×70×60=420,000. The teeth of pinions a×b×c=15×18×24=6,480. Therefore, (420,000×10)÷6,480=648, or the speed of pinion c.

It is also sometimes necessary to determine the horsepower that can be transmitted by a cast-iron spur gear. This may be calculated by the following formula, which is taken from literature issued by the Philadelphia Gear Works, Philadelphia, Pa.: For spur gears, Hp.=(F×T²×V)÷(L×53), where F=width or face of tooth, in inches; T=thickness of tooth at pitch line, in inches; V=velocity at pitch line in feet per minute; L=length of tooth from root to point, in inches. This formula allows a safety factor of 8 and is based on an ultimate tensile strength of 30,000 lb. per square inch for the cast iron.

Another rule is given by the Christiana Machine Company, Christiana, Pa., as follows: To find the power a cast-iron spur gear will

## Some Information That Is Frequently Needed

To obtain the distance between the centers of two gears, add the number of teeth together and divide half the sum by the diametral pitch.

To find the pitch diameter of a pair of gears, divide the centers by one-half the sum of the teeth and multiply the quotient by the number of teeth in each gear. The product is the pitch diameter of each gear.

The circular pitch of a gear is equal to the constant 3.1416 divided by the diametral pitch.

To find the number of teeth in a gear and pinion, multiply the center distance by two times the diametral pitch and divide the product by the ratio of pinion plus ratio of gear. This quotient multiplied by ratio of pinion equals number of teeth in pinion, and by ratio of gear equals number of teeth in gear.

To find speed or number of teeth of one gear, when speed and number of teeth of mating gear are known: Divide product of speed and number of teeth of first gear by the speed or number of teeth of the second gear.

For a train of gears use the continued product of the gears and the continued product of the pinions as in the case of a single gear and pinion.

## For Every-Day Calculations On Gears These Rules Will Come in Handy

| No. of Rule | To Find | Having | Rule |
|---|---|---|---|
| 1 | Diametral Pitch | Circular Pitch | Divide 3.1416 by the Circular Pitch. |
| 2 | Diametral Pitch | Pitch Diameter and Number of Teeth | Divide Number of Teeth by Pitch Diameter. |
| 3 | Diametral Pitch | Outside Diameter and Number of Teeth | Divide Number of Teeth plus 2 by Outside Diameter. |
| 4 | Pitch Diameter | No. of Teeth and Diametral Pitch | Divide Number of Teeth by Diametral Pitch. |
| 5 | Pitch Diameter | No. of Teeth and Outside Diameter | Divide the product of Outside Diameter and No. of Teeth by No. of Teeth plus 2. |
| 6 | Pitch Diameter | Outside Diameter and Diametral Pitch | Subtract from the Outside Diameter the quotient of 2 divided by the Diametral Pitch. |
| 7 | Pitch Diameter | Addendum and Number of Teeth | Multiply Addendum by the Number of Teeth. |
| 8 | Outside Diameter | Number of Teeth and Diametral Pitch | Divide Number of Teeth plus 2 by the Diametral Pitch. |
| 9 | Outside Diameter | Pitch Diameter and Diametral Pitch | Add to the Pitch Diameter the quotient of 2 divided by the Diametral Pitch. |
| 10 | Outside Diameter | Pitch Diameter and Number of Teeth | Divide the Number of Teeth plus 2 by the quotient of Number of Teeth divided by Pitch Diameter. |
| 11 | Outside Diameter | Number of Teeth and Addendum | Multiply the Number of Teeth plus 2 by Addendum. |
| 12 | Number of Teeth | Pitch Diameter and Diametral Pitch | Multiply Pitch Diameter by the Diametral Pitch |
| 13 | Number of Teeth | Outside Diameter and Diametral Pitch | Multiply Outside Diameter by the Diametral Pitch and subtract 2. |
| 14 | Thickness of Tooth | Diametral Pitch | Divide 1.5708 by the Diametral Pitch. |
| 15 | Addendum | Diametral Pitch | Divide 1 by the Diametral Pitch |
| 16 | Working Depth | Diametral Pitch | Divide 2 by the Diametral Pitch |
| 17 | Whole Depth | Diametral Pitch | Divide 2.157 by the Diametral Pitch |

*Diametral Pitch is the Number of Teeth to each inch of Pitch Diameter.

transmit when the diameter, face, pitch and r.p.m. are given, multiply the diameter in inches by the face in inches by the r.p.m. by the factor corresponding to the pitch, given below:

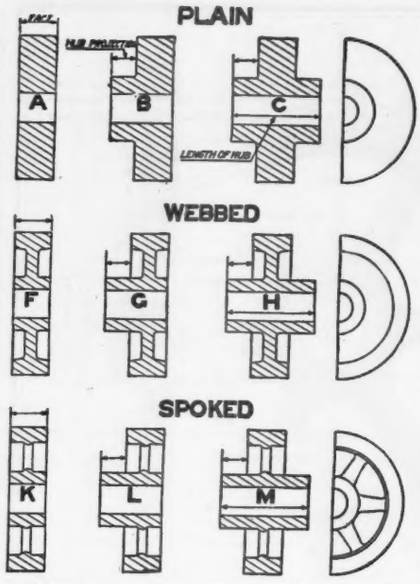
| Pitch | Factor | Pitch | Factor |
|---|---|---|---|
| 1 in. | 0.0018 | 2½ in. | 0.00468 |
| 1¼ in. | 0.00228 | 2¾ in. | 0.00516 |
| 1½ in. | 0.00276 | 3 in. | 0.00564 |
| 1¾ in. | 0.00324 | 3¼ in. | 0.0061 |
| 2 in. | 0.00372 | 3½ in. | 0.0066 |
| 2¼ in. | 0.0042 | 4 in. | 0.00756 |

This table is calculated on a safety factor of 7½ for cast-iron spur gearing. The ratings given are based upon usual steady-load conditions and are not sufficient to care for unusual and heavy intermittent service, which generally requires gears of 50 to 100 per cent more capacity. It is also recommended that the horsepower of the smaller gear of a pair be used.

Gears are made in three general styles: plain, webbed and spoked. As the name indicates, the plain gear is solid and of uniform thickness, except for the hub or central portion, which may or may not be extended out. In the webbed gear the portion between the rim and the hub is made thinner for the purpose of saving weight. In the spoked gear still more weight is saved by employing spokes instead of a solid web, between the rim and hub. Large gears, like pulleys and flywheels, are frequently split or made in halves which are bolted together, to facilitate handling.

Although the formulas previously given refer only to cast-iron spur gears, these may be made of other materials and finished in various ways, depending on the requirements. Thus, for many purposes a gear with molded or cast teeth is fairly satisfactory. In most instances, however, the teeth are cut, which gives a longer-lived, quieter and more efficient gear. Carbon and alloy steel gears, carefully heat-treated, are often employed for special purposes. The strength of such gears is, of course, considerably greater than that of those made of cast iron.

*Mortise Gears* are sometimes used in cases where noise is objectionable, although they are inferior in strength, efficiency and length of life to properly cut cast-iron gears. These gears are essentially iron wheels provided on the rim with slots into which wooden teeth are wedged. The teeth are made of hardwood, usually maple. The mating wheels are generally of cast iron and should have machine-cut teeth, in order to prevent excessive wear on the wooden, mortise-wheel teeth.




**Different styles of gear wheel and hub construction.**

## Non-Metallic Gears and Pinions Used for Silent Drives

The increasing use of motor drives and higher speeds for machinery in general has, during the past few years, given great impetus to the development of silent drives, through the use of gears or pinions made of some non-metallic material. Rawhide is extensively used for this purpose, and gears and pinions made from it may be obtained from a number of manufacturers. Rawhide gears and pinions are generally made with brass, cast-iron or steel flanges or end plates. These flanges are riveted or bolted under heavy pressure and usually extend to the top of the teeth, serving, of course, to increase the strength.

High-grade rawhide pinions are usually assumed to have about 75 per cent of the strength of a cast-iron pinion, and when used under the proper conditions will usually give satisfactory service. It is important, however, to avoid the use of rawhide pinions when there is severe reciprocating or intermittent motion against them, nor should they be mated with a cast gear, as the irregular spacing of the teeth and the rough surface will cause rapid wear. Inasmuch as rawhide is animal matter, excessive heat will quickly destroy it, while moisture will cause it to swell and then shrink when dried out. Rawhide gears should, therefore, not be exposed to much heat, and should be kept dry.

Mineral oil should not be used as a lubricant, nor should oil working out of bearings be allowed to get on rawhide gears or pinions. A small amount of hard grease and graphite is the best lubricant to use on rawhide gears.

Pinions made of cloth have also been successfully used. They are made of cloth or cotton filler compressed under hydraulic pressure and tightly held by metal flanges, as in the case of rawhide gears. In addition, there are on the market several makes of gears and pinions formed from special fabrics impregnated with a binder. It is claimed that these are unaffected by oil or water, that they can be substituted for untreated steel, cast-iron, bronze and non-metallic gears and pinions and when properly applied and lubricated will often outlast cast-iron or brass wheels.

Useful as spur gears are for many conditions of service, they nevertheless possess certain inherent characteristics which are undesirable. For example, the teeth come in contact over their entire length at one time and the whole load is first thrown on the end of the tooth. Although this strain is gradually reduced as the teeth mesh more closely, the initial strain is sudden and severe. In the case of spur pinions and gears the drive is practically a series of impacts.

Editor's Note: Acknowledgment is made to the following concerns for assistance in furnishing information and photographs for this and the succeeding article: Boston Gear Works, Norfolk Downs, Mass.; The Chicago Rawhide Mfg. Co., Chicago, Ill.; Christiana Machine Co., Christiana, Pa.; The Cleveland Worm Gear Co., Cleveland, O.; The Falk Corporation, Milwaukee, Wis.; Fawcus Machine Co., Pittsburgh, Pa.; Foote Bros. Gear and Machine Co., Chicago, Ill.; William Ganschow Co., Chicago, Ill.; General Electric Co., Schenectady, N. Y.; D. O. James Manufacturing Co., Chicago, Ill.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; The Meachem Gear Corporation, Syracuse, N. Y.; New Process Gear Corporation, Syracuse, N. Y.; Niles - Bement - Pond Company, New York, N. Y.; R. D. Nuttall Co., Pittsburgh, Pa.; Philadelphia Gear Works, Philadelphia, Pa.; The Poole Engineering and Machine Co., Baltimore, Md.; Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

*Practical Requirements of*

# Fuse Protection For Motors

## *Without Starters or That Drive Heavy Loads Which Are Slow to Accelerate*

By WILLIAM E. SEWARD,
*Electrical Engineer, American Manufacturing Company, Brooklyn, N. Y.*

IT is often difficult to give adequate protection to motors. This is particularly true in the case of small motors which are started by connecting them directly across the line and for all motors which are subject to temporary overloads whether at starting or in running. There are a large number of motors installed under these conditions in the textile mills of the American Manufacturing Company. In the severe service mentioned, if a fuse is installed large enough to pass heavy starting and temporary overload currents, it will be too large to protect the motor. This results in many burnouts. If the fuse is small enough to protect the motor windings, it blows frequently which results in lost time and production. To get rid of this annoyance and expense, various schemes were studied. The plan adopted was to install fuses having a time lag inversely proportioned to the current at which they blow. This did not necessitate the purchase of other new equipment. Six months of operation have proved the plan a very satisfactory one as many troublesome conditions have been eliminated.

Since the writer made the first installation of these fuses, he has applied them to numerous motors. There are a number of small motors in the plant which are thrown directly on the line without control apparatus. Formerly if fuses large enough to pass the high starting current were used, they would not properly protect the motors under running conditions nor against the high current demands of polyphase motors when accidentally running single-phase. In some of the smaller motor installations a double-throw switch is used. One position of this switch has heavy starting fuses, while the other has fuses of the proper size for running. The switch is thrown from starting to running position after the motor is up to speed. Many of these switches are not equipped with a spring device to prevent their being left in the starting position. As a result, switches were very often left connected to the large starting fuses which do not give proper protection. This carelessness in operation was present in spite of instructions posted near the switches. It would be better, in a case of this kind, to employ a switch which could not be left in the starting position. It is not, however, the general custom throughout the country to do this on account of the expense of the special switch.

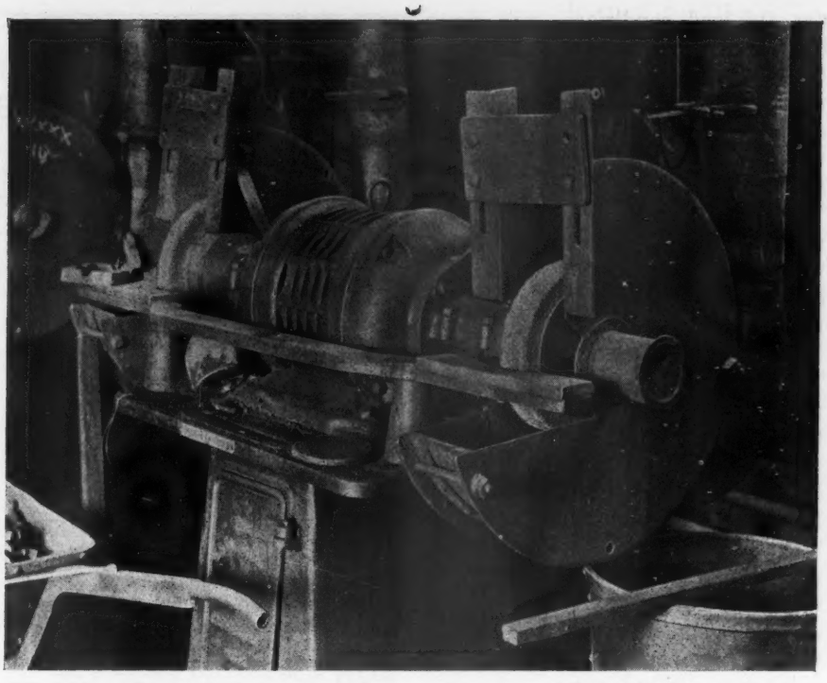


**Fig. 1—For protecting grinders a fuse with a time-lag is desirable.** This motor draws a heavy starting current but the protection should be such that it will not operate until the motor is up to speed.

**IN THIS ARTICLE Mr. Seward tells how he has eliminated motor burnouts caused by overloads and single-phase operation by the use of a fuse having an appreciable time lag which is inversely proportional to the current. He has applied this solution particularly to small motors which have no starting equipment and to large motors which drive a load that is heavy and slow to start. He discusses also the use of smaller branch feeders which a fuse of this kind makes allowable, and the reduction of heating in panel boxes by using a fuse of the characteristics described.**

To pass the starting current of these small motors, the fuses must be rated at about 300 per cent of full-load current. If a motor is allowed to run on fuses of this size it has no protection against single-phase trouble or overload. Under full-load conditions, three-phase motors running single-phase will draw between 173 per cent and 200 per cent of full-load current. This is enough to burn out the motor windings and yet it will not blow the large fuses. The current through the one active phase of a delta-connected motor will be even greater than this. If the line current is 173 per cent of the full-load current, the current through the one active phase will be 300 per cent of the current which normally runs through this phase. Two-phase motors when running single-phase un-

der full-load conditions, will draw between 200 and 225 per cent of full-load current. Consequently, a fuse rated at 300 per cent of full-load current will not blow although the motor will burn out when running single-phase.

In trying out the time-lag fuse with alternating-current motors, it was found that the same set of fuses could be used for both starting and running protection. Table I was constructed for use on these motors. The starting fuses originally employed were rated at two and three times full-load current, while the running fuse was rated at one and one-quarter times the full-load current. It was found that in almost all cases a time-lag fuse rated at one and one-seventh times full-load current was suitable. A fuse of this size gives sufficient time for the motor to come up to speed. At the same time, it gives very close protection for overload and single-phase conditions. The time which will elapse before the fuse blows at starting current is given in one column of the table.

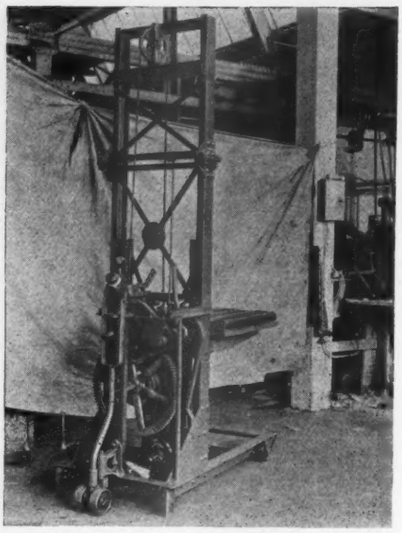


**Fig. 2—A tiering machine starts lifting at full load and the protective device must allow for a heavy momentary current.**

The fuses were particularly applicable to direct-current motors which had slow-speed heavy-duty starting conditions. Elevators, hoists, pumps, rolls, crushing and grinding machines and compressors are typical of the services referred to. The starting currents are often three times normal, decreasing slowly as the speed increases and reaching normal at full speed. Under such conditions the former fuses were chosen large enough to carry the heavy current required during the slow accelerating period. As a consequence little overload protection was afforded the apparatus by these fuses. In nearly every installation of this kind it was found that a time-lag fuse rated at about 25 per cent overload would give the motor sufficient time to reach normal running speed before the fuse blew. See Table II.

A fuse of this size will protect the motor properly against abnormal running conditions. With the original fuses a size one and one-half times the full-load current was employed. This was too large to give the correct protection.

In putting in new motor installations using the time-lag fuse, it was found that smaller branch conductors could be used than was possible with the old fuses. The reason is that the time-lag fuses could be employed with a lower rating, while the size of conductor is limited by the size of the fuse which protects it. This difference in conductor size is shown in Tables I and II. These give the sizes of fuses of both kinds to be used with various sizes of motors. Corresponding to the fuse sizes, the sizes of wire required are shown.

On lighting circuits there was no advantage in using the time-lag fuse, except where the following conditions were found: In panels where the regular fuses and their connections were so highly loaded that the resulting heat was causing trouble the time-lag fuses were found to reduce the temperature to safe values. Also, the fuses are employed on some lighting circuits which are loaded to capacity with lamps and from which current is sometimes taken temporarily to operate portable electric tools. The starting current of the small tool motors would sometimes blow the lighting fuses. The time-lag fuses were put in to take care of the temporary overload current.

Among the installations which had been giving trouble were twelve groups of 1/30-hp. motors driving humidifiers. Much trouble was

## Table 1—A. C. Motor Wiring Data Using Time-Lag Fuses of Sizes Indicated

| Hp. | Amp., Full Load | Amp., if running single-phase fully loaded. | Size of Fuse, Amp. | | | Blowing time of Time-Lag Fuse at Starting Current Seconds. | Wire Size, B. S. | |
|---|---|---|---|---|---|---|---|---|
| | | | Regular | | Time-Lag | | With Regular Fuse | With Time-Lag Fuse |
| | | | Starting | Running | Starting and Running | | | |
| **220-Volt Three-Phase Motors** | | | | | | | | |
| 1 | 3.7 | 7 | 10 | 10 | 6 | 8 | 14 | 14 |
| 3 | 9.3 | 16 | 30 | 15 | 12 | 3 | 10 | 14 |
| 5 | 12 | 21 | 45 | 20 | 15 | 3 | 8 | 14 |
| 7½ | 22 | 38 | 60 | 30 | 25 | 3 | 6 | 10 |
| 10 | 25 | 43 | 65 | 30 | 30 | 3 | 6 | 8 |
| 15 | 38 | 66 | 80 | 50 | 45 | 8 | 4 | 6 |
| 20 | 52 | 90 | 100 | 65 | 60 | 16 | 2 | 4 |
| 25 | 64 | 100 | 130 | 80 | 75 | 16 | 1 | 2 |
| 30 | 77 | 133 | 160 | 100 | 90 | 30 | 0 | 2 |
| 40 | 107 | 185 | 220 | 135 | 125 | 30 | 00 | 0 |
| 50 | 118 | 204 | 240 | 150 | 135 | 26 | 000 | 00 |
| **440-Volt Three-Phase Motors** | | | | | | | | |
| 1 | 1.5 | 3 | 10 | 5 | 5 | 10 | 14 | 14 |
| 3 | 4.25 | 8 | 15 | 6 | 6 | 10 | 14 | 14 |
| 5 | 6.5 | 11 | 20 | 10 | 8 | 3 | 12 | 14 |
| 7½ | 10 | 17 | 30 | 15 | 12 | 3 | 10 | 14 |
| 10 | 13 | 23 | 35 | 15 | 15 | 3 | 10 | 14 |
| 15 | 20.3 | 35 | 50 | 25 | 25 | 10 | 8 | 10 |
| 20 | 24 | 42 | 65 | 30 | 30 | 10 | 6 | 8 |
| 25 | 30 | 60 | 70 | 40 | 35 | 12 | 6 | 8 |
| 30 | 36 | 63 | 80 | 50 | 45 | 20 | 4 | 6 |
| 35 | 42 | 73 | 90 | 60 | 50 | 24 | 2 | 6 |
| 40 | 47.5 | 82 | 100 | 65 | 60 | 42 | 2 | 4 |
| 50 | 62 | 107 | 125 | 80 | 75 | 42 | 1 | 4 |

## Table II—Wiring Data for D. C. Motors Which Start Under Heavy Loads

| Hp. | Amp. Full-Load | Size of Heavy-Duty Starting and Running Fuse Amp. | | Wire Size B. & S. | |
|---|---|---|---|---|---|
| | | Regular | Time-Lag | With Regular Fuse | With Time-Lag Fuse |
| 0.5 | 2 | 4 | 4 | 14 | 14 |
| 1 | 4 | 6 | 5 | 14 | 14 |
| 2 | 8 | 12 | 10 | 14 | 14 |
| 3 | 12 | 20 | 15 | 12 | 14 |
| 4 | 16 | 25 | 20 | 10 | 12 |
| 5 | 19 | 30 | 25 | 8 | 10 |
| 7½ | 28 | 40 | 30 | 6 | 8 |
| 10 | 38 | 60 | 40 | 4 | 6 |
| 15 | 56 | 85 | 60 | 1 | 4 |
| 20 | 75 | 115 | 85 | 0 | 2 |
| 25 | 94 | 145 | 100 | 00 | 1 |
| 30 | 113 | 170 | 125 | 000 | 0 |
| 40 | 150 | 225 | 165 | 0000 | 000 |
| 50 | 188 | 280 | 200 | 300,000 | 200,000 |

caused by single-phase operation of these groups resulting from the blowing of one fuse of a group. The motors were connected in groups of sixteen and seventeen, only one switch and one set of fuses being used on each group. The starting current for a group was so high that a standard fuse which would pass the starting current would not give any protection on single-phase operation.

Altogether there are 200 motors in twelve groups. The motors are rated 220 volts three-phase. The running current drawn by a group of seventeen motors is 2.7 amp. and the load of one group is about ½ hp. One single-throw oil switch is used to throw the 200 motors directly across the line. Under this condition the starting current of a group of seventeen is 17 amp. Individual fuses were not employed on the motors as a fuse large enough to pass the starting current would not give adequate protection on overload or single-phasing. Each group was protected by standard 20-amp. fuses. This was the smallest commercial size which would pass the starting current. However, when one of these blew, as often happened, the motors drew a single-phase current of 10.2 amp. Often the motors ran under this condition until one or more of a group was seriously burned. The 20-amp. fuses gave no protection at this current.

**Fig. 3—For starting a long shaft like this the motor should have time-lag protection.**

Among the solutions considered was the installation of a phase-failure relay and automatic circuit breaker in each circuit to open it under single-phase or overload conditions. This was an expensive solution and therefore other methods were examined. Another solution would have been installing double-throw switches in each branch. Such switches throw the load directly on the line for starting and transfer it to the fuses for running. Such a switch fused with 6-amp. running fuses would have answered the purpose. This switch, however, must be so constructed that the blades cannot be left in the starting position. This adds the complications of a spring or some such arrangement. Switches of this kind are on the market.

Instead of buying these switches, however, to replace those already in use, the time-lag fuse was tried out in the old fuse clips. The operation with this arrangement has been perfectly satisfactory. There have been no burnouts or other trouble since the fuses were put in about six months ago. A 6-amp. time-lag fuse was used. This fuse, according to tests made by the Electrical Testing Laboratories, will blow in about two seconds at a load of 17 amp. which is the starting current, see Table III. This gives plenty of time for the motors to come up to speed. At the same time in case of failure of one fuse the single-phase current of 10.2 amp. will blow the other fuses in eight seconds, which is quick enough to prevent damage to the motors.

As the removal of trouble had been so simple in the case just related, the same remedy was tried on several other motors having bad starting conditions. The motor in one instance is a 3-hp., 220-volt, direct-current machine which drives a water pump and is automatically controlled by the water level in a tank. Both motor and controller gave considerable trouble. The controller is of the magnetic lockout type and the motor draws 250 per cent current at starting as it starts heavily loaded. This starting current is 27 amp. for four seconds. The original fuses were of 25-amp. rating in order to stand this starting current. However, they gave practically no protection for most

overload conditions as the full-load current is only 11.8 amp. As a result the motor was burned out twice and the controller was badly injured once. In addition, blowing of the fuses often caused the pumps to stop when they should have been supplying water, a shortage of which might be dangerous.

Consequently the old fuses were replaced by time-lag fuses rated at 15 amp. This rating gives adequate protection from occasional overloads and also allows the starting current of 27 amp. to pass for four seconds without blowing. Since these fuses were put in there has been no trouble.

Another case where much trouble had been experienced was that of a 3-hp., 220-volt, two-phase, 60-cycle motor driving a tiering machine. The starting current on this motor is 35 amp. for one second while the running current is 6.9 amp. at full load. The original fuse was rated at 45 amp. This was replaced by a 25-amp. fuse having the time-lag feature. This fuse allows a starting current of 50 amp. for three seconds. Since its installation the troubles which were formerly frequent have stopped.

Another motor driving a water pump had been giving trouble. This was a 5-hp., 220-volt, two-phase, 60-cycle motor with a full-load current of 11.5 amp. On starting the pump the motor drew 60 amp. for three seconds. A 50-amp. fuse had been used and this blew frequently. It was replaced with a 30-amp. time-lag fuse which stopped the trouble. This 30-amp. fuse will stand 60 amp. for three seconds—Table III.

### Smaller Branch Feeder Permissible

A way in which a smaller branch motor feeder may be used in conjunction with these time-lag fuses is shown in the case of a large three-phase motor driving a finishing machine. The particular motor mentioned is typical of a large number of motors in this plant. It is phase-wound and the protective equipment consists of an oil switch with inverse time-limit overload relay and no-voltage protection and an ammeter. The motor is controlled by a drum switch and resistance in the secondary. A safety type disconnecting switch with fuses is mounted on a column near the point where the motor feeder taps the main. The motor is phase-wound and is rated 35 hp., 440 volts, three-phase, 25 cycles, 42 amp. The starting current is 80 amp. to 110 amp. for variable lengths of time depending on the load. The original fuse was of 100-amp. capacity. It was replaced by a time-lag fuse which will pass 130 amp. for twenty seconds. With this fuse a smaller conductor might be used for the branch-wire than with the 100-amp. fuse. For the 100-amp. fuse a wire of No. 2 gage would be used. (This would be a No. 3 gage conductor according to Rule No. 8 c-3 of the National Electrical Code, but No. 3 is not usually available and therefore No. 2 would be used.) With the 65-amp. fuse a No. 6 conductor may be used.

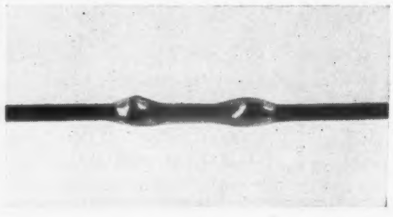


**Fig. 4—A fuse link which has a time-lag. The two beads on the copper strip are composed of cadmium, tin and antimony.**

### Overheating of Safety Panelboard Eliminated

While the writer was examining these fuses it was found that they remain considerably cooler in operation than fuses previously used. This led to their trial in a number of eight-circuit dead-front panelboards which overheated excessively. All the circuits in these boards were carrying from 103 to 114 amp. though their capacity was only 100 amp. each. The heat given off by the heavily loaded fuses was largely retained by the tight steel panel cases and slate barriers. The metal parts of the circuits became overheated to such an extent that fuses blew frequently. Some of the switch bridges also were injured and had to be replaced. To stop the damage being done by the excessive heat, the covers were removed from the panelboards to be left until a remedy was found. A simple solution of the problem would have been the addition of one independent circuit to each panel so arranged as to relieve the fully loaded circuits. That solution would have been rather expensive. The substitution of larger fuses would have been dangerous because one set of fuses might carry too high a current if the box had become cold either from running all night without load or when all other fuses were carrying light loads.

While looking for a remedy for this trouble the writer discovered the low (*Continued on page* 119)

## Table III—Time of Blowing, Temperature and Voltage Drops of Time-Lag Fuses

| Per Cent of Rated Current | 250-VOLT FUSES* | | | | 600-VOLT FUSES* | | | |
|---|---|---|---|---|---|---|---|---|
| | 30-Amp | 60-Amp | 100-Amp | 200-Amp | 30-Amp | 60-Amp | 100-Amp | 200-Amp |
| | Time of Blowing | | | | | | | |
| | Min.Sc. | Min.Sc. | Min.Sc. | Min.Sc. | Min.Sc. | Min.Sc. | Min.Sc. | Min.Sc. |
| 125 | 115:15 | 113:00 | 109:30 | 110:00 | 116:00 | 113:00 | 106:00 | ..... |
| 140 | 4:19.6 | 6:00 | 10:15 | 12:00 | 4:15 | 5:45 | 9:15.6 | 17:00 |
| 150 | 50.9 | 1:37 | 4:00 | 4:30.5 | 42 | 1:54 | 3:29 | 5:40.3 |
| 175 | 7.6 | 16 | 26 | 41 | 17 | 24 | 56.1 | 1:13.6 |
| 200 | 3 | 7 | 10 | 15 | 10 | 12 | 21.1 | 30.4 |
| 250 | 2.2 | 1.8 | ..... | 4.7 | 3.3 | 5.6 | 8.1 | 12.6 |
| 300 | 0.8 | 1.8 | 2.5 | 3 | 2.5 | 5 | 4.9 | 7.4 |
| | Temperature, Degrees Centigrade | | | | | | | |
| 100 | 87 | 82.6 | 52.1 | 49.8 | 60.5 | 71.8 | 44 | 40.8 |
| 110 | 93.8 | 88.5 | 56 | 52.9 | 68 | 79.5 | 47.2 | 46 |
| 115 | 102.9 | 97 | 61 | 57.2 | 75.6 | 87.5 | 51 | 50.5 |
| | Volts Drop | | | | | | | |
| 100 | 0.1920 | 0.1264 | 0.1179 | 0.1039 | 0.1878 | 0.1744 | 0.1402 | 0.1203 |
| 110 | 0.2251 | 0.1512 | 0.1396 | 0.1249 | 0.2264 | 0.2030 | 0.1648 | 0.1433 |
| 115 | 0.2606 | 0.1809 | 0.1528 | 0.1326 | 0.2508 | 0.2309 | 0.1807 | 0.1568 |

*These fuses are made in ratings as low as 3 amp. and the fuses under 30 amp. in size follow fairly closely the figures given above for the 30-amp. fuses.

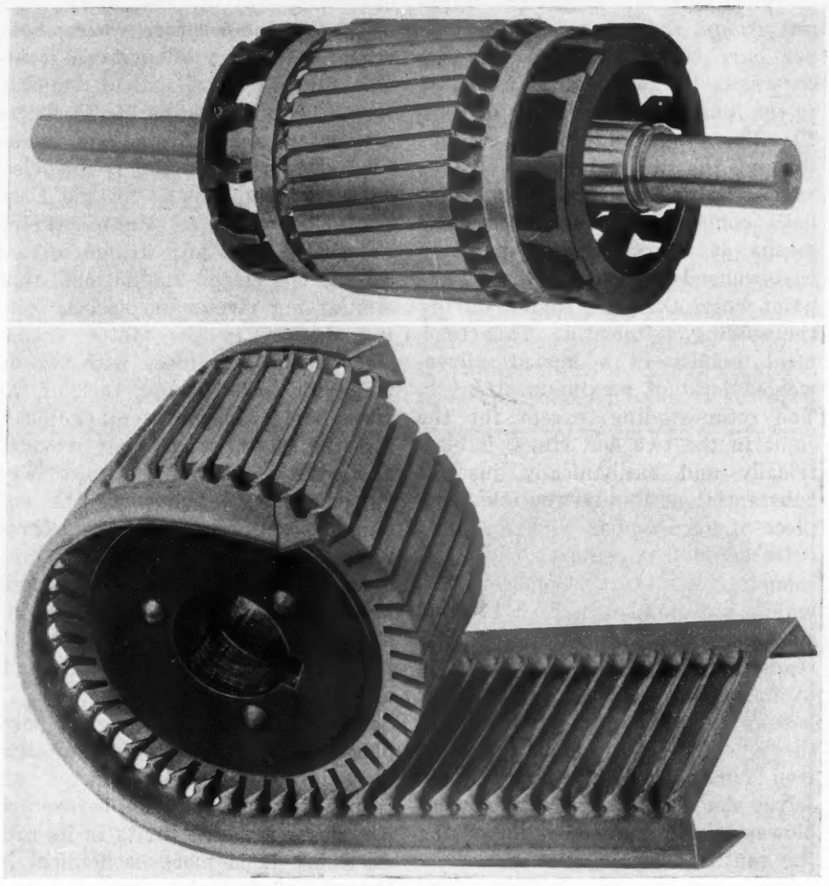
**SOME OUTSTANDING developments were made during 1922 in electrical and associated mechanical equipment. In this article details are given covering the construction and operation of new devices from the standpoint of their application to works operation and maintenance.**

*A Review of the New*

# Products Produced In 1922

## *Of Interest to Operating and Maintenance Men in Industrial Works*

By E. H. HUBERT,
*Associate Editor, Industrial Engineer*



*This rotor has a one-piece winding consisting of an integral sheet of copper punched and formed by a special mechanical process and machine wrapped around the rotor core with the copper bars expanded into the core slots by swaging. The two end rings are silver welded at one point. It is used in the new L. A. motors manufactured by the Louis Allis Company, Milwaukee, Wis.*

AMONG the 1922 developments in equipment used by operating and maintenance departments of industrial works, there are some outstanding features and many other details which, although they relate to smaller equipment, are nevertheless of equal interest in improving the operation of electrical and associated mechanical systems. Among the most important advances are those made in motors, both synchronous and induction. The value of the electric steam generator under many conditions is becoming more appreciated. A record has been made in the size of steel melting furnaces. Electric ovens are being successfully applied to more processes. Control for paper mills has been simplified and perfected. Rolling mill control has been improved. Among the smaller equipment developed are motor starters, distribution and wiring appliances, repair and construction machinery and tools. Material-handling equipment has also made forward strides, as indicated on page 41 of the January issue under the title, "Better Methods for Handling Materials."

Among motor developments is a synchronous motor designed to start at full load without the use of a clutch, several improvements in squirrel-cage motors, a self-starting polyphase induction motor, and several small motors. The new synchronous motor which does not require a clutch for starting under a heavy load has been developed by the General Electric Company. The motor is so constructed that it is possible when starting to bring the armature (which is normally the stator) up to synchronous speed, regardless of the load. The load is connected to the rotor, which remains stationary until the stator has come up to speed. Then the field is applied in the ordinary way. The rotor is gradually brought up to speed by applying a powerful band brake to the stator. The brake is applied gradually and the driven machine is brought up to speed without a shock. The stator is then held stationary by the band brake and the motor functions as an ordinary synchronous motor. It is claimed that this motor can develop a starting torque of from 150 per cent to 300 per cent of normal torque throughout the entire starting period. This motor is illustrated in *D* of Fig. 1.

In induction motors the big improvements have been a new rotor construction in one machine and in others, sturdier shafts, frames, and brackets, increased feed of oil to bearings, improved ventilation, more durable installation and enclosed motor terminals. The companies that have brought out new squirrel-cage motors are the Louis Allis Company, Milwaukee, Wis.; Electric Controller & Manufacturing Company, Cleveland, Ohio, and the Wagner Electric Manufacturing Company, St. Louis, Mo. The three motors are illustrated in *A*, *B* and *C* of Fig. 1. The Louis Allis Company has produced a motor with a new squirrel-cage rotor construction. In this motor, the entire winding of the rotor consists of an integral sheet of copper, punched and formed by a special mechanical process. This

one-piece winding is machine-wrapped around the rotor core, the copper bars being expanded into the core slots by swaging, as indicated in the illustration at the top of page 89. The single joint which extends through the two end rings, is silver welded, after which the metal at both connections is processed by means of a contracting operation that rehardens the copper at the point where the heat, applied during the welding, softened it. This treatment results in a lapped, silver-welded joint of maximum strength. The rotor-winding, except for the joint in the two end rings, is electrically and mechanically just as substantial and indestructible as a piece of pure copper pipe.

On account of being fabricated of comparatively thin copper stock, which material has a high thermal conductivity, this rotor winding readily conducts the heat generated in it toward the ends of the rotor bars where this heat is dissipated through the action of the malleable iron fans. The rotor bars themselves also constitute a very efficient blower, thus materially increasing the ventilation.

The rotor core, as a self-contained unit, may be pressed on and off the shaft readily as it has a straight keyway. Otherwise it is largely conventional except that it employs open slots without the usual overhanging tooth tips. Experience has shown that so long as a suitable relation is maintained between the air gap and slot width, the performance does not suffer as regards power factor and efficiency, and that a rotor core of this construction, with a suitable winding results in exceptionally high starting and running torques. These abnormally heavy starting and running torques have led the manufacturers to increase the shaft size over and above the usual practice for a given rating which, in combination with the liberal bearings, fabricated from a phosphor-bronze, insures exceptionally long life in service.

While great stress has been laid on the mechanical ruggedness of this new line of motors, the electrical characteristics have received equally careful attention. In addition to the exceptional starting and running torques, all motors are guaranteed to carry their full rated load continuously with a temperature rise not exceeding 40° C., and after their ultimate temperature has been reached, to carry 25 per cent overload for two hours with a temperature rise not exceeding 55° C. These motors are made in standard industrial sizes, voltages and frequencies.

In the motor made by the Electric Controller & Manufacturing Company, the stator frame is cast around the stator laminations, thus eliminating rivets and special locking devices in the stator frame. This motor is provided with two oil rings for each bearing, each of the rings being sufficient to oil the bearing, the second ring being provided as a safety feature. The rotor is of rugged construction with the end rings cast onto the rotor bars. These rings are heavy enough to stand overload currents without undue heating. The bearing part of the shaft is of large size, with the extension for pulleys or gears of standard dimensions.

The Wagner motor is a new polyphase, heavy-duty, 40-degree design. It is lighter in weight than for corresponding ratings made before and has closer machine limits in its production. It is more economical in the use of materials employed and takes in more air and is, therefore, better ventilated and an improved design from all electrical and mechanical standpoints.

Another induction motor which provides improved ventilation has been developed by American Electric Motors, Inc., Milwaukee, Wis. This motor is entirely closed and has outlet and inlet pipes for air circulation. It is intended to be used in a plant where the air is not clean and to draw in clean air from outside. Ball bearings are used in this motor.

A self-starting polyphase induction motor in capacities of 5 hp. to 30 hp. has been developed by the Fidelity Electric Company, Lancaster, Pa. It is said that this motor starts at 100 per cent of full-load torque.

Fractional-horsepower split-phase induction motors have been brought out by the Reynolds Electric Company, Chicago, Ill., and a fractional repulsion-start induction motor has been developed by the Dayton Fan and Motor Company, Dayton, Ohio. The France Manufacturing Company, Cleveland, Ohio, has developed a fractional-horsepower synchronous motor.

The Master Electric Company of Dayton, Ohio, has in production a new motor which is made in sizes from 1/3 to 1½ hp. A distinctive feature of the new motor is the symmetrical frame. The frame dimensions on the commutator end are all identically the same as on the shaft projection end. This new motor has interchangeable frames for alternating and direct current. Among the other features are the compact short-circuiting device; the removable, self-aligning, phosphor bronze bearings, and the dual-wick oiling system.

The complete line of Master motors is from ⅛ to 1½ hp. alternating-current, single-phase, repulsion induction motors; polyphase induction motors and compound-wound direct-current motors; and up to 2-hp. high speed. The repulsion-induction type motor is of exceptionally high starting torque with low starting current consumption. They are designed to start extremely heavy overloads with so slight drop in line voltage that the annoyance of light flickering is practically eliminated. They also operate on heavy overloads and under low adverse voltage conditions.

### Improvements in Control Equipment

Notable developments have been made in control equipment for paper-mill drive, printing presses, steel-mill and other rolling mills, metal and woodworking plants, oil-well drives, and ice-making equipment. There has also been a number of new motor starters.

An improvement in paper-machine drive has been made by the General Electric Company that reduces greatly the size of the control apparatus. The principle of the voltage regulator is applied for the control of each section of the paper machine; so that any change in load, voltage or speed instantly applies a correction. This regulator type of control, like the control brought out about two years ago, is dependent upon synchronous motors operating in parallel for maintaining a constant relation of speed between the main driving motors. But the regulator type allows the use of very small synchronous units in place of units about 20 per cent of the capacity of the main motors. The control equipment consists of a ⅛-hp. synchro-

nous motor driving a cone pulley 4 in. in diameter and in length connected by belt to another cone of the same size. The relative speed of the two cones may be changed by shifting the belt. The second cone carries a small disk with a number of contacts. Another disk of the same size is attached to the main drive motor on the paper machine. These disks rotate in the same direction, the contact points making and breaking contacts very rapidly when there is a slight angular displacement between the two disks. The making and breaking of the contacts respectively short circuits or inserts a resistance in the direct-current motor field. The result is a fixed speed on this direct-current motor.

For the control of large printing presses, a new line of controllers for both alternating and direct current has been developed by the General Electric Company. This involves the use of a simpler and more substantial pilot motor and master switch and employs an improved type of operating contactor. Three groups of these controllers have been installed

**Fig. 1—New developments in motors, control and circuit-devices.**

*A*, *B* and *C* are three new squirrel-cage induction motors. Ruggedness, large shafts, durable insulation, better oiling arrangements and improved rotor construction are among their features. At *D* is a synchronous motor whose "stator" revolves on starting. It is gradually brought to rest by means of a brake. In the meantime the rotor has increased in speed from zero to full speed. This arrangement allows starting under heavy load without a clutch. At *E* and *F* are two fractional-horsepower motors. Three motor starters are shown in *G*, *I* and *J*. At *H* is an across-the-line motor-starting switch. In *K* and *O* are, respectively, a 6,600-volt and a 4,400-volt insulator especially adapted for factory conditions such as dust, fumes, smoke, etc. A device for making a wall or ceiling outlet is shown at *L*. At *M* is a fuse cutout and at *N* is a "reducer" to allow a small fuse to be used in large clips.

in the new building of the *Public Ledger* in Philadelphia to operate a twelve-unit press.

Several interesting developments in mill drives have been reported by the Westinghouse Electric & Manufacturing Company. These include a new system of paper calender drive and control that involves the use of a commutator-type frequency changer. The calender is driven by a wound-rotor induction motor. The motor operates under running conditions from a bus giving a standard frequency, but when threading-in it is connected to a bus giving about six cycles per minute, supplied by the frequency changer. This arrangement eliminates a separate threading-in motor which has been used in the past.

Several installations on rolling mills have been made in the past year, involving improvements in control and arrangement of equipment. A control method for motor-driven, cold-rolled-strip reels has been worked out by the Westinghouse company. The problem in this application is to maintain a constant tension in the strip being delivered from the mill and the various conditions of mill speed and effective diameter of the reel. In the plan worked out a generator driven from the last stand of rolls supplies power to the motor which drives the reel. A voltage regulator controlled by the armature current of the motor is connected across a resistance in the field of the motor. This regulator maintains the motor current constant, thus keeping the torque of the motor at a fixed value which results in the same pull being exerted on the strip at all times, with a given setting. An electrically driven rod reel has been put in operation during the past year in a mill where it is necessary that one of the reels follow almost exactly the speed of the last stand. The delivery speed of the mill is sometimes as high as 3,200 ft. per minute; therefore, a slight error would result in a large amount of slack or would pull the rod in two. A small alternating-current generator is driven from the main mill motor and another by a 100-hp. reel motor. These two generators operate a mechanical differential which remains stationary as long as their speeds are the same. When the speed of one or the other of the pilot generators changes, the differential rotates and operates the contact of a vibrating relay which increases or decreases the field on the reel motor. It has been found possible to hold the speed very accurately with this equipment. The Westinghouse company has developed a system of control for use in connection with coke-pushing machines and ladle cranes when two or more motors are used, of which only one operates at a time.

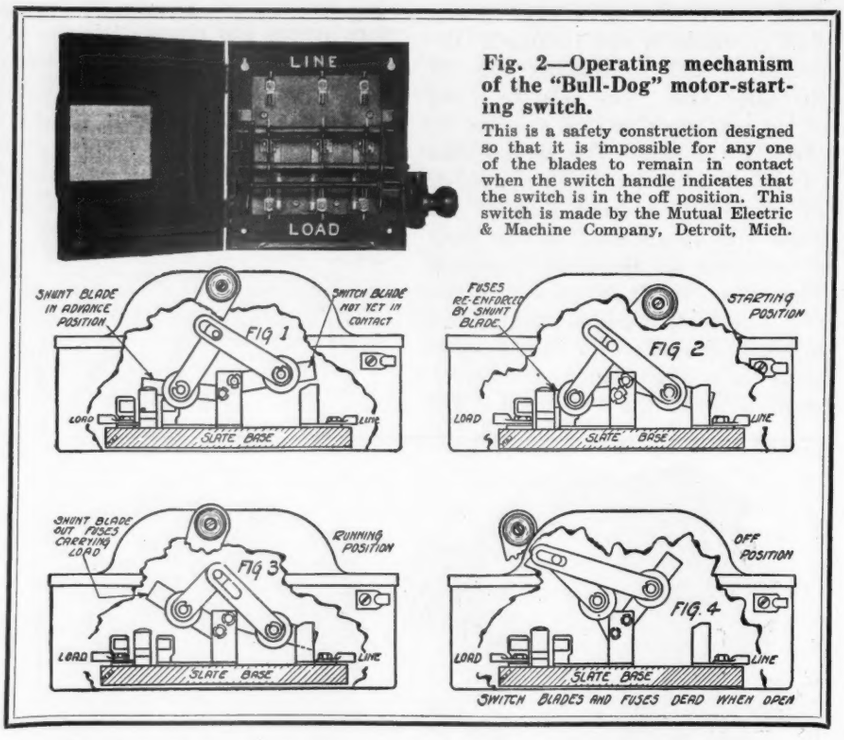



**Fig. 2—Operating mechanism of the "Bull-Dog" motor-starting switch.**

This is a safety construction designed so that it is impossible for any one of the blades to remain in contact when the switch handle indicates that the switch is in the off position. This switch is made by the Mutual Electric & Machine Company, Detroit, Mich.

In the woodworking industry an interesting multiple control has been developed by the Westinghouse company. This is used on a molder which requires four motors for the cutting head and a four-speed motor for the feed, which develops 5 hp. on all four speeds. Instead of using an individual auto starter with automatic control, a special control was designed for all five motors and mounted in one common casting. The controllers are of the drum type. The overload relays are so connected that an overload on any one motor shuts down the entire machine. There is a tendency in both woodworking and metalworking machines toward the use of direct-connected motors requiring speeds above 3,000 r.p.m. To obtain these speeds, induction frequency changers are used for getting a speed up to 15,000 r.p.m.

Among the starting devices which have been developed is the resistance-type starter made by the Sundh Electric Company, Newark, N. J. This starter is made for both hand and automatic operation. It throws a resistance in the primary circuit of an induction motor in balanced steps. This starter is illustrated in *J* of Fig. 1.

The Allen-Bradley Company, Milwaukee, Wis., has brought out an improved push-button starting switch for squirrel-cage motors. This is an enclosed across-the-line switch which provides overload protection and low-voltage protection and has arc shields and blowout coils to prevent flashovers. Copper-to-copper rolling contacts are provided with stiff pressure while in contact to insure adequate capacity under all loads. The contactor arms are mounted on a single crosspiece attached to the clapper arm and the construction is such that it results in a quick-acting clapper. This starter is designed for alternating-current motors up to 10 hp. and is shown in *H* of Fig. 1.

The Industrial Controller Company, Milwaukee, Wis., has also put out, for small alternating-current motors, an across-the-line starter which has push-button control. This starter has under-voltage protection, over-voltage protection and phase-failure protection. It is built in three sizes which will give from ½ to 7½-hp. range for 110 to 550 volts. A three-pole, 30-amp., 220-volt hand-operated safety motor-starting switch has been put on the market by the Union Electric Manufacturing Com-

pany, Milwaukee, Wis. This switch is enclosed in a steel box.

A motor drive and automatic switch for typesetting machines has been put on the market by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. The feature of this control is that the motor is automatically stopped after a predetermined time if no work is being done on the typesetting machine.

The Monitor Controller Company, Baltimore, Md., has developed enclosed starters for motors which consist of a small circuit-breaker and terminal limit relays that provide no-voltage, overload and single phasing protection. The starter is designed for location near the motor so that local temperature conditions affect both.

A new safety motor-starting switch known as the "Bull Dog" has been brought out by the Mutual Electric & Machine Company, Detroit, Mich. The construction is shown in Fig. 2. Tests were conducted in which the rotor of a 7½-hp., 40-degree, 230-volt, a.c., 3-phase, induction motor was blocked so that it could not move, and a 30-amp., 250-volt, 3-pole switch was thrown on and off repeatedly, showing a reading on the ammeter of from 100 to 130 amp. The manufacturers claim that the switch successfully withstood this test in every respect, and that it was in first-class condition after the test was completed. This switch is of rugged construction and, as shown by the test, was built to stand extreme conditions.

Another across-the-line starter has been developed by the Trumbull Electric Manufacturing Company, Plainville, Conn. This is of the enclosed safety-switch type and is made for motors of not over 5 hp. and for 110 to 550 volts. This starting box has inverse-time protective fuses for overload protection. It is shown in *G* of Fig. 1.

Equipment for automatically reclosing a circuit after interruptions on 200- or 600-volt direct-current circuits has been developed by the General Electric Company. This equipment is designed especially for mine installations, for circuits feeding hoists, cutting and drilling machines, and the like. In case of an overload on a circuit protected with this equipment the protected circuit is opened and is closed again only when

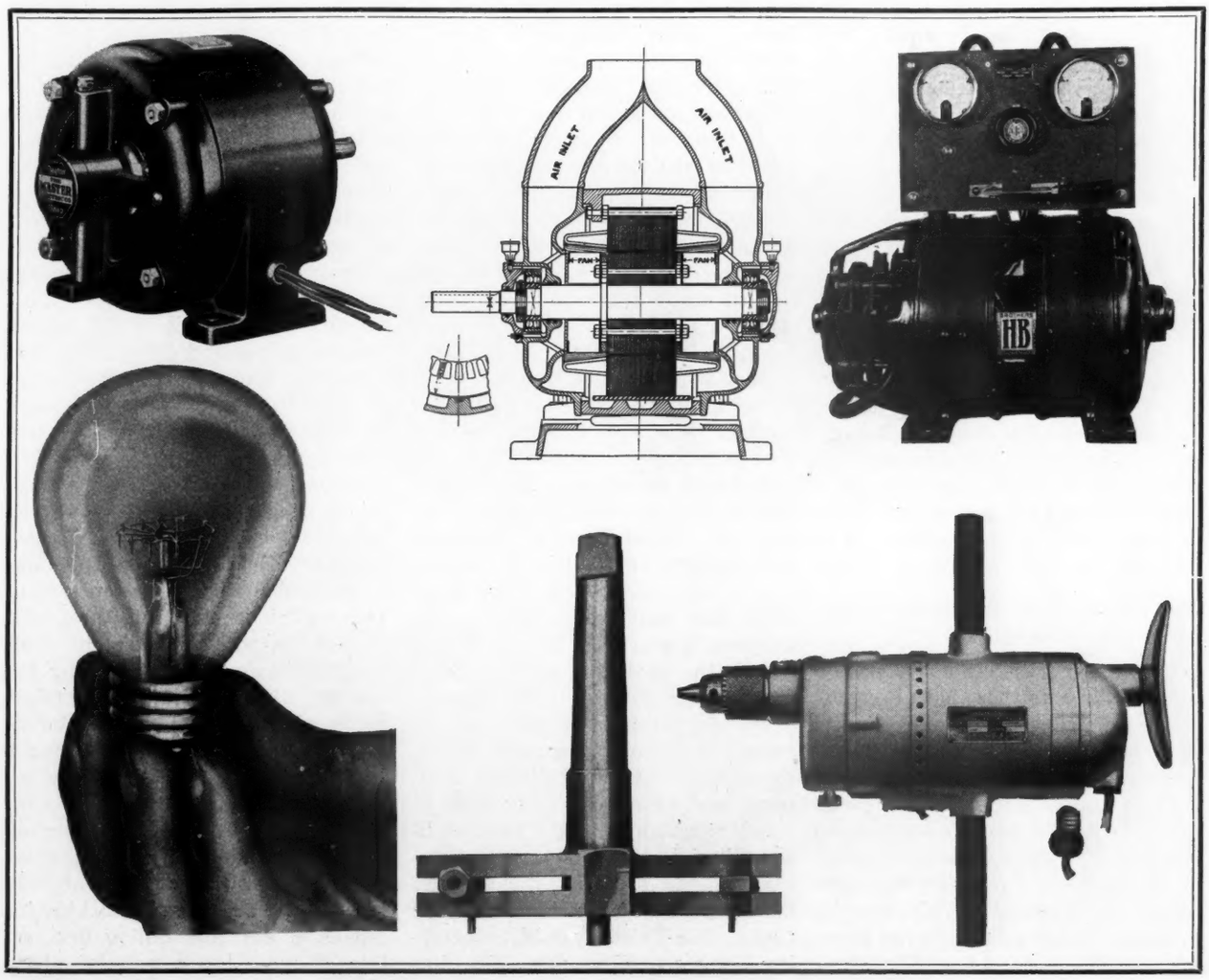



**Fig. 3—Three new motors, the mill-type lamp and two tools.**

Reading from left to right in the top row, the first motor is a new design made by the Master Electric Company, Dayton, Ohio. It has interchangeable frames for alternating and direct current and is built in sizes from ⅛ to ½ hp. The second motor is made by the American Electric Motors, Inc., Milwaukee, Wis. This is a ball-bearing, self-ventilating design for use where a completely enclosed motor is required. The third illustration in the top row is a constant potential battery-charging outfit made by the Hobart Brothers Company, Troy, Ohio. The first illustration at the left in the bottom row is the mill-type lamp now made in standard sizes of 25 and 50 watts for 115 volts, and 50 watts for 230 and 275 volts. This lamp is made by a number of the lamp companies. The middle illustration in the bottom row is a drill press cutter for making holes in sheet metal, fiber and the like and is made by Paul W. Koch & Co., Chicago, Ill. The portable drill shown at the right in the bottom row is made by Jones, MacNeal & Camp, Warsaw, Ind. It is a sturdy design with two speeds and full ball bearings, operated by a motor of liberal rating.

the fault is cleared off the line. The automatic operation eliminates delays that might arise from the necessity of reconnecting the load by hand.

For use in accurate pressure, vacuum and thermostatic control a new type of mercury-contact switch has been developed by the Federal Gauge Company, Chicago, Ill. It consists of a glass tube containing mercury, which is brought into contact with the control wires when the tube is put in a certain position. These tubes are made in single-circuit and three-way designs. They will operate at 10 amp., 110 volts, or 5 amp., 220 volts. The same type of switch is also supplied in a smaller size for relay operation.

A switch which is automatically controlled by a remote thermostat has been developed by the Minneapolis Heat Regulator Company. This switch is designed for temperature control on electrical heating units, refrigerating apparatus, automatic oil burners, and the like. It is capable of handling alternating current at 110 volts and 20 amp. The operation of the switch depends upon a 7½-volt relay which is operated by the thermostat; the relay in turn closes the circuit on a 110-volt closing coil.

A timer for automatically operating a signal at the end of a predetermined time is now being made by the Stromberg Electric Company, Chicago, Ill. It is designed for use in manufacturing processes where strict account must be kept of time, such as heat treating, enameling, and so forth. The instrument does not contain a clock mechanism, but is operated by a synchronous motor. At any time the timer indicates how long the process has been in operation and how much longer it will continue until a signal is given.

### Equipment Used in Distribution and Wiring

For use on distribution systems of industrial plants there have been developed during the last year circuit-breakers, safety switches, insulators, fuses, flexible conduit and fittings.

Wide application has been made of an enclosed circuit-breaker of small size by The Cutter Company of Philadelphia, Pa., under the trade name of "Urelite." This circuit-breaker is designed to do what fuses are intended to do and combines protection for the circuit with safety for the operator. It can be readily adjusted to any desired current within a wide range and when once set the operation thereafter is constant and invariable. This breaker is operated by an insulating handle mounted on the outside of the box.

A line of totally enclosed circuit-breakers has been brought out by the Roller-Smith Company, New York City. These breakers may be had with plain overload and with under-voltage and shunt trip as desired. They are made for 250 volts and 500 volts. One of the types manufactured cannot be closed on an overload. The capacities are from 5 amp. to 200 amp. A safety switch for across-the-line starting at 250 and 500 volts has been brought out by the Z. & H. Manufacturing Company, Chicago, Ill. It is made with two, three and four poles.

Two insulators designed especially for low-voltage lines such as used in industrial concerns have been developed by the R. Thomas & Sons Company, East Liverpool, Ohio. One of these is the "Baby-Link Type," which is a small design of the well-known Hewlett insulator. This insulator, which is shown in Fig. 1 at *O*, is designed for 2,300 and 4,000-volt lines and for guy and span construction. Its mechanical strength is 6,000 lb. The other insulator is of the pin type. It is for 6,600 volts and under and is recommended for service where salt spray, fog, dust, smoke or fumes tend to coat the surfaces. It is illustrated in *K* of Fig. 1.

Several new fuses have been brought out. A. L. Lewis Company, Canton, Ohio, has developed a fuse plug which shows a small red flag underneath the mica as soon as the fuse blows. The Westinghouse Electric & Manufacturing Company has brought out a line of renewable fuses of the cartridge type. This fuse has a bare link of the drop-out type. The feature of the fuse is the method of getting rid of the hot gases which pass through perforated washers at each end, arranged to give a long and broken passage. The General Electric Company has designed a plug fuse in which no solder is used. The Southern Electric Manufacturing Company, Bristol, Tenn., has placed on the market a line of cartridge and plug fuses. The Trico Fuse Manufacturing Company, Milwaukee, Wis., has put out a powder-filled fuse which is built of fiber, having no porcelain in its makeup. It is claimed that the fuses are very accurate because a restricted link is used in place of the ordinary fuse wire. The makers claim that these fuses weigh only 33 lb. per 1,000, packed for shipment.

A fuse reducer which will allow a fuse of small rating to be placed in fuse clips designed for a fuse of larger rating has been made by the Plainville Electrical Products Company, Plainville, Conn. This reducer is illustrated in *N* of Fig. 1. Dead-front plug-fuse cutout bases have been developed by the Bryant Electric Company, Bridgeport, Conn. One of these is shown in *M* of Fig. 1. A device designed to pull out and replace the closed types of fuses without danger to the operator has been put on the market by the Waterbury Fuse Puller Company, Waterbury, Conn. It will handle fuses of practically any size.

A flexible armored cable with a flat cross-section has been developed by the National Metal Molding Company, Pittsburgh, Pa. The chief advantage claimed for this molding is that it can be readily covered by the thickness of plaster commonly used on brick and tile surfaces. Fittings made specially for use with this oval cable are also made. By means of a special connector the oval cable may be secured to round knockouts in ordinary boxes. A bushing for fastening ½-in. conduits in a ¾-in. knockout is now made by the Adapti Company, Cleveland, Ohio. The Chicago Fuse Manufacturing Company, Chicago, Ill., has placed on the market a shallow sectional switch box specially designed for use in thin partitions. It is 1½ in. deep overall, 3¾ in. long and has a ½-in. knockout at each end. The Arrow Electric Company, Hartford, Conn., has developed a shallow push-button switch. This switch is only 1 in. deep and is made in both the straight push and the toggle types. A fitting for use on 2½-in. and 3-in. conduit where wires are brought into a building through conduit has been brought out by the Killark Electric Manufacturing Company, St. Louis, Mo. This device will fit either vertical or horizontal conduit. The Bryant Electric Company, Bridgeport, Conn., has developed two devices for making inexpensive wall and ceiling fixtures. One of these has a porcelain base

while the other has a brass base. The first of these is illustrated in *L* of Fig. 1. This company has also designed a cleat-base indicating porcelain snap switch for use in factories where open wiring is employed. An attachment plug which is armored by means of a brass ring to which is also fastened a clamp for holding the cord, has been developed by the Arrow Electric Company, Hartford, Conn. This metal piece is designed to prevent the composition cap from breaking and to prevent the cord from being pulled out of the binding screws.

**Fig. 4—Machines and tools for repair and construction work.**

At *A* is a commutator grinder which can be applied to practically any make of motor. A winder for armatures up to 5 hp. in size is shown at *B*. The taping machine at *C* is motor driven, the motor being part of the machine. A shop tool which can be used for turning and for milling and boring at all angles is illustrated at *D*. The device at *E* is employed to test all the coils in a small motor at once. Electrically heated solder pots (*F*) are becoming more popular. An arrester with solid electrolyte which requires no charging is shown at *K*. In using the battery filler pictured at *H* a small lamp lights when the cell is full. For taking a discharge test of a cell, the device shown at *I* needs only one hand of the battery man. At *J* is a welding outfit which can be transported easily to any section of a plant.

## Repair-Shop Equipment and Tools for Repair and Construction

A motor-driven taping machine has been brought out by the Chapman Electrical Works, St. Louis, Mo. The taper is belted to a slow-speed motor on which is mounted a cone clutch which gives instantaneous and fine adjustment in speed correspond-

ing to pressure on a treadle. This machine is illustrated in *C* of Fig. 4. A machine for turning a commutator without removing the armature from its bearings has been introduced by George Bender, New York City. This machine is made to take direct-current motors or generators or slip-ring alternating-current motors in sizes from 5 to 200-hp. The cutting tool is insulated from its holder. This device is shown in *A* of Fig. 4. A machine for winding the armatures of small motors has been developed by T. F. Rhoades, New York, N. Y., and is shown at *B* in Fig. 4. The guide feeding the wire onto the armature is moved by means of a cam shown near the wheel at the left of the machine. It is claimed that very fine wire and many turns can be wound with this machine. It is made for sizes up to 5 hp. A commutator-grinding tool designed for mounting on the brush holder stubs has been developed by the Martindale Electric Company, Cleveland, Ohio.

A brush connection which has been devised by the Boxill-Bruel Carbon Brush Company, Indianapolis, Ind., is shown in Fig. 7. This connection is made up as follows: Copper wire is pressed to a solid mass. The brushes are then milled to exact size and copper plated with a hole drilled for attaching the shunt. A tin washer is put on the front and a wing washer on the back to exactly fit the size of hole. This wing washer is threaded. A screw is then inserted through the front washer and through the brush and to the wing washer and screwed up tight. It is then immersed in a hot tin bath, which thoroughly saturates the pigtail and binds it securely to the copper plating on the brush and wing washer on the back.

When this brush is sawed through the connection it shows a solid mass where the pigtail connection is formed. The screw being solid to the copper pigtail prevents it from moving back and forth, and the wing washer fits in a slot in the brush which eliminates any turning movement. There are no high spots in the connection to become highly saturated. In the case where the pigtail is inserted in a hole in the top of the brush and a pin driven in on the side, there are one or two points which are higher than the rest of the material, which causes this contact to carry the current and in a short time jar away around the carbon or the metal by fusing and oxidizing so that the pigtail may be pulled out with little difficulty. In the construction described there is practically no voltage drop between the end of the shunt and the top of the brush.

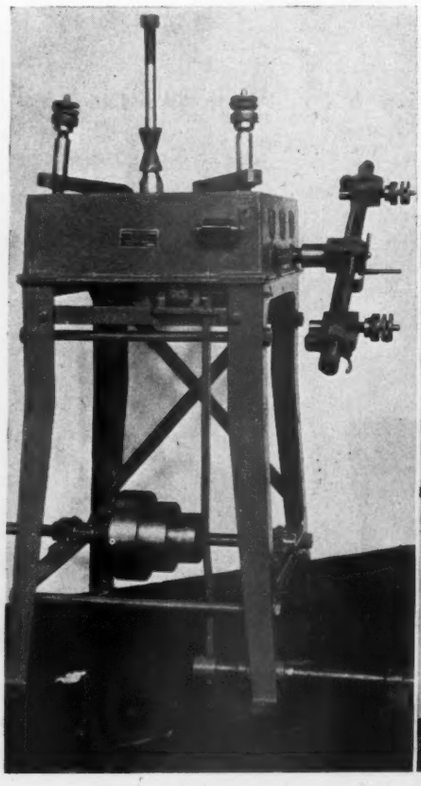
**Fig. 5—An adjustable coil winding form made by Armature Winding Company, Charlotte, N. C.**

A bias-woven varnished-cambric tape which has no seams has been put out by the Irvington Varnish & Insulator Company, Irvington, N. J. It can be continuously wound on without the necessity of stopping to cut out a seam.

Paul W. Koch Company, Chicago, Ill., maker of the "Jiffy" adjustable cutter, a hand tool for cutting circular holes of various diameters in metal and fiber plates, boxes, etc., has placed on the market a new tool known as the "Jiffy" drill press cutter. This cutter takes the place of the clumsy, old-fashioned, makeshift flycutter used in many shops. It can be used to cut holes in fiber sheets, metal plates, metal cabinets, and any kind of work of that nature which can be placed on a press. They are made in two sizes with cutting diameters from 1¼-in. to 3-in. and 1½-in. to 6-in. The knives are renewable and easily adjustable. This tool is to be used on machines at a speed of 100 r.p.m. or less on fiber material and 50 r.p.m. on metal. The standard knives cut metal 1/16 in. to 3/16 in. and special knives may be obtained which will cut thicknesses up to 1¼ in.

A machine for soldering all the joints of a commutator at one time has been developed by P. E. Chapman Electrical Works, St. Louis, Mo. This is a production machine arranged for one or a limited number of commutator sizes. A special design is made for soldering two commutators at once. The machine can also be employed for soldering rotors.

For testing the complete winding of a small armature at one time, an "armeter" has been built by P. E. Chapman Electrical Works, St. Louis, Mo. This instrument is intended for production work and one instrument will fit only one type of armature. A picture of this instrument is shown in *E* of Fig. 4. A complete



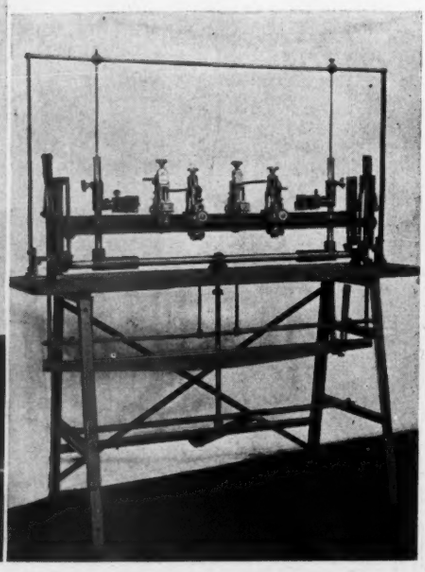


**Fig. 6—Browning coil-winding machine and coil spreader.**

This equipment is constructed to wind a variety of dimensions of coils that can be pulled into the required shape by the spreader shown at the right. It uses clamping arrangements which make it easy to adjust the heads of the winder and remove the coil when wound. The spreader is also designed for quick insertion and release of coils. This apparatus is made by the Mutual Foundry & Machine Company, Atlanta, Ga.

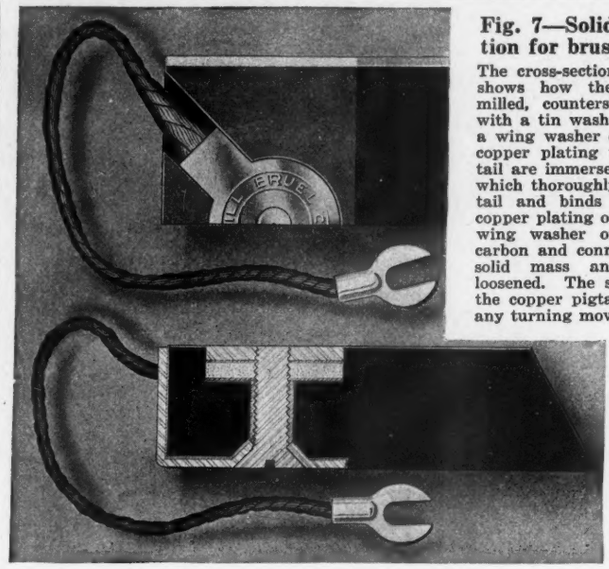


**Fig. 7—Solid pigtail connection for brushes.**

The cross-section in the illustration shows how the brush is drilled, milled, countersunk and assembled with a tin washer on the front and a wing washer on the back. After copper plating the brush and pigtail are immersed in a hot tin bath which thoroughly saturates the pigtail and binds it securely to the copper plating on the brush and the wing washer on the back.. The carbon and connections become one solid mass and cannot become loosened. The screw is soldered to the copper pigtail, thus eliminating any turning movement. In the construction described there is practically no voltage drop between the end of the shunt and the top of the brush Nor are there high spots to carry excessive current. This connection is made by Boxill-Bruel Carbon Brush Company, Indianapolis, Ind.

test bench for automotive repair shops, to be used for testing starting motors, generators, magnetos and distributors, has been built by Paul G. Niehoff & Company, Inc., Chicago, Ill. Tests can be made while the machine is in operation.

Among other items of equipment useful in a repair shop is a solder pot developed by the Westinghouse Electric & Manufacturing Company. These pots are made in 10, 30, 150 and 750-lb. sizes. The last two are equipped with automatic temperature control. An electrical heating furnace for heating soldering irons has been developed by the Op-al Electric & Manufacturing Company, Indianapolis, Ind. These furnaces are made in several sizes and can be attached to an ordinary lighting system.

A new type of soldering-iron heater has been developed by the Instantaneous Heater Company, San Francisco, Calif. The iron is heated by placing it across two carbon contacts fed from a 7-volt transformer. Current stops on removal of the iron.

An electrically heated soldering iron with a switch in the handle and a detachable cord has been put on the market by the Rhone Electric Company, Inc., Minneapolis, Minn. The iron is furnished in four sizes for 110 and 220 volts. A motor-driven gas blow torch has been made by the Armature Coil Equipment Company, Cleveland, Ohio. This torch is mounted on a stand which can be adjusted to any height. It is useful for removing insulation, soldering large commutators, burning out motor windings and other purposes.

Among the useful tools which have been developed for shop work is a three-in-one machine made by the Triplex Machine Tool Corporation, New York City. This machine is shown in *D* of Fig. 4. It may be used for turning, milling and boring. The motor and revolving shaft are mounted on a base which slides on an arm constructed in the shape of a quarter of a circle. This enables work to be done at any angle. A new design of pipe wrench shown in *G* of Fig. 4 has been brought out by the Greenfield Tap & Die Corporation, Greenfield, Mass. For pulling fish wires, T. J. Cope, Philadelphia, Pa., has brought out an instrument having two handles which are placed on each side of the wire while the pulling motion clamps the wire.

## Equipment for the Battery Man

There are a few developments in which the man who handles batteries will be interested. A battery-charging outfit which will give 400 amp. under normal load and 500 amp. for a short time, has been placed on the market by the Hobart Brothers Company, Troy, Ohio. The generator is a 3-kw. machine with a commutator at both ends, each of which will deliver 200 amp. at 7½ volts. With the (*Continued on page* 101)

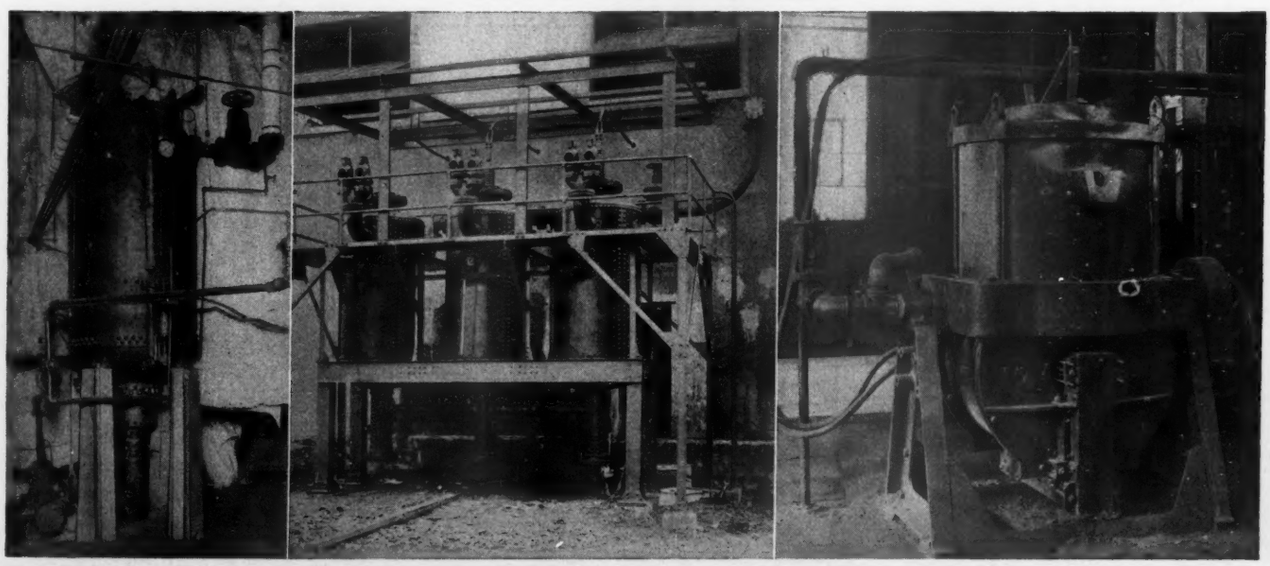


**Fig. 8—New electrically heated boilers and a brass-melting furnace.**

At the left is a smaller steam generator, while in the center is an 18,000-kw. electric boiler rated at 1,800 boiler horsepower, 12,000 volts, three-phase, 25 cycles. It evaporates 54,000 lb. of water per hour at 125 lb. pressure. The outside dimensions are 21 ft. by 10¼ ft. by 22 ft. It is installed at the Cliff Paper Company, Niagara Falls, N. Y. The 75-kw. repulsion-induction furnace shown at the right is said to have a consumption of 200-kw. hr. per ton of brass melted in continuous operation.

*Winding and Connecting Data for Some*

# Old Direct Current Armatures

## *Including Those of Railway, Crane, Mining and Mill Type Motors and Some Generators*

By A. C. ROE,

*Shop Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company*

*An armature of this type and size sees hard service and its trips to the repair shop are frequent unless it is properly wound.*

**IN THIS ARTICLE Mr. Roe gives the coil pitch, commutator pitch and lead throw for some of the old types of direct-current motors and generators. These types are the S, SA, M, K, R, railway, crane, mining and mill types of Westinghouse make and a number of old style General Electric motors. The accompanying tables have been prepared from years of winding experience.**

TIME may be saved when stripping an armature if the coil pitch, the commutator pitch and the lead throw is known in advance. In order to save this time the accompanying tables have been prepared for some old types of Westinghouse and General Electric motors. The Westinghouse motors included are types S, SA, M, K and R, and old types of railway, crane, mine and mill motors. A number of General Electric railway motors are also included. The data has been compiled from many rewinding jobs.

When stripping an armature the winder first finds out from the nameplate or by inspection what type the motor is. If the type is covered by the tables he need not stop to take the pitches and throw. He should, however, record the nameplate data and count the total number of slots and commutator bars. The coils can then be removed, saving one to use as a guide in making the new coils and to get the size of wire, number of turns, etc.

After the coils are made and ready to be put back on the armature, the tables should be consulted. The table for the type of the motor being rewound is first found and then the line referring to the particular winding is located. This is determined by the number of slots and commutator bars in the motor. For instance, if it is a type M motor with thirty-one slots and 93 bars, the motor winding data is found in the third line of the table referring to type M motors. Here we see that the coil pitch is 1 and 7, the pitch of the leads on the commutator is 1 and 48, and the throw of the bottom lead is 1 and 16.

It will be noted that some of the

### Table I—Number of Slots and Bars in Different Frame Sizes of Types S and SA Westinghouse Motors

| *Frame No.* | *No. Slots* | *No. Bars* |
|---|---|---|
| 1 | 31-41 | 31-61-81-93 |
| 2 | 33-35-41-47-49 | 49-97-99-105-123-141 |
| 3 | 37-41-49-57 | 49-73-97-111-123-147-171 |
| 4 | 39-45-49-53-61 | 49-89-97-105-117-147-183 |
| 5 | 37-41-44-47-49-65 | 49-73-93-97-98-123-147-195 |
| 6 | 41-47-53-59 | 53-94-105-123-141-159-177 |
| 7 | 41-49-69 | 49-81-97-98-123-147-207 |
| 8 | 47-53-65-75 | 53-75-93-94-105-106-141-159-195 |
| 9 | 47-53-57-69 | 53-93-105-106-114-141-159-171-207 |
| 10 | 31-41-45-53-65 | 89-90-74-111-123-135-163-185-195-265 |
| 11 | 37-41-45-53-65 | 81-82-90-111-123-135-195-219-265 |
| 12 | 41-49-53-55-61-65-76 | 82-106-123-152-164-165-183-195-245 |
| 13 | 31-41-45-53-55-57-64-71-81. | 61-82-110-123-128-135-165-171-213-143-265 |

tables give the frame numbers. Where the frame number of a motor is known, this will help to determine which data to use. Sometimes this frame number is marked on the nameplate. There are marks on the commutator end of the shafts of Westinghouse types R, M, S, SA and railway motors. The marks might, for instance, be: No. 5-3T-97B-220V-30Hp., etc. In this case the "No. 5" would be the frame number.

If the motor is one that falls under the heading of Table V, it may be more difficult to tell exactly which data should be used for it. In this case it may be necessary to refer not only to the number of slots and bars in the motor, but also to its voltage and the size of wire and the number of turns in the coils. For instance, if we have a motor with 47 slots and 93 bars, there are several lines in Table V which might refer to this particular motor. However, if we know that the motor is rated at 500 volts, this limits the selection to four of the motors. Furthermore, if we know that the coils have four turns of No. 10 wire, while the motor is

## Table II—Connecting Data for Four Different Types of Westinghouse Motors

| No. Slots | No. Commutator Bars | Coil Pitch, A-B | Commutator Pitch, C-F | Throw of Bottom Lead, C-D | Refer to Drawing Numbers |
|---|---|---|---|---|---|
| **Types S and SA Motors** | | | | | |
| 31 | 31 | 1-8 | 1-17 | 1-6 | 1 |
| 31 | 61* | 1-8 | 1-32 | 1-11 | 2 & 7 |
| 31 | 93 | 1-8 | 1-48 | 1-19 | 3 |
| 33 | 99 | 1-9 | 1-51 | 1-15 | 3 |
| 35 | 105 | 1-10 | 1-54 | 1-14 | 3 |
| 37 | 73* | 1-10 | 1-38 | 1-11 | 2 & 7 |
| 37 | 74† | 1-10 | 1-38 | 1-11 | 2 & 8 |
| 37 | 111 | 1-10 | 1-57 | 1-16 | 3 |
| 37 | 185 | 1-10 | 1-94 | 1-26 | 5 |
| 39 | 77* | 1-10 | 1-40 | 1-12 | 2 & 7 |
| 39 | 117 | 1-10 | 1-58 | 1-17 | 3 |
| 41 | 81* | 1-11 | 1-42 | 1-11 | 2 & 7 |
| 41 | 82† | 1-11 | 1-42 | 1-11 | 2 & 8 |
| 41 | 123 | 1-11 | 1-63 | 1-18 | 3 |
| 41 | 163* | 1-11 | 1-83 | 1-23 | 4 & 7 |
| 41 | 164† | 1-11 | 1-83 | 1-23 | 4 & 8 |
| 44 | 98† | 1-11 | 1-50 | 1-15 | 2 & 8 |
| 45 | 89* | 1-11 | 1-46 | 1-15 | 2 & 7 |
| 45 | 90† | 1-11 | 1-46 | 1-15 | 2 & 8 |
| 45 | 135 | 1-11 | 1-69 | 1-21 | 3 |
| 47 | 93* | 1-12 | 1-48 | 1-15 | 2 & 7 |
| 47 | 94† | 1-12 | 1-48 | 1-15 | 2 & 8 |
| 47 | 141 | 1-12 | 1-72 | 1-21 | 3 |
| 49 | 49 | 1-12 | 1-26 | 1-9 | 1 |
| 49 | 97* | 1-12 | 1-50 | 1-16 | 2 & 7 |
| 49 | 98† | 1-12 | 1-50 | 1-16 | 2 & 8 |
| 49 | 147 | 1-12 | 1-75 | 1-22 | 3 |
| 49 | 245 | 1-12 | 1-124 | 1-36 | 5 |
| 53 | 53 | 1-13 | 1-28 | 1-9 | 1 |
| 53 | 105* | 1-13 | 1-54 | 1-16 | 2 & 7 |
| 53 | 106† | 1-13 | 1-54 | 1-16 | 2 & 8 |
| 53 | 159 | 1-13 | 1-81 | 1-24 | 3 |
| 53 | 265 | 1-13 | 1-134 | 1-38 | 5 |
| 55 | 109* | 1-13 | 1-56 | 1-17 | 2 & 7 |
| 55 | 165 | 1-13 | 1-84 | 1-25 | 3 |
| 57 | 171 | 1-14 | 1-87 | 1-25 | 3 |
| 59 | 177 | 1-15 | 1-90 | 1-25 | 3 |
| 61 | 183 | 1-15 | 1-93 | 1-27 | 3 |
| 64 | 128† | 1-16 | 1-65 | 1-19 | 2 & 8 |
| 65 | 195 | 1-17 | 1-99 | 1-26 | 3 |
| 69 | 207 | 1-17 | 1-105 | 1-26 | 3 |
| 71 | 213 | 1-17 | 1-108 | 1-31 | 3 |
| 75 | 75 | 1-18 | 1-39 | 1-12 | 1 |
| 76 | 152† | 1-18 | 1-77 | 1-23 | 2 & 8 |
| 81 | 243 | 1-20 | 1-123 | 1-34 | 3 |
| **Type M Motors** | | | | | |
| 31 | 31 | 1-7 | 1-17 | 1-7 | 1 |
| 31 | 61* | 1-7 | 1-32 | 1-11 | 2 & 7 |
| 31 | 93 | 1-7 | 1-48 | 1-16 | 3 |
| 41 | 41 | 1-9 | 1-22 | 1-8 | 1 |
| 41 | 81* | 1-10 | 1-42 | 1-13 | 2 & 7 |
| 41 | 82† | 1-10 | 1-42 | 1-13 | 2 & 8 |
| 47 | 47 | 1-11 | 1-25 | 1-9 | 1 |
| 47 | 93* | 1-11 | 1-48 | 1-15 | 2 & 7 |
| 47 | 141 | 1-11 | 1-72 | 1-22 | 3 |
| 45 | 135 | 1-11 | 1-69 | 1-21 | 3 |
| 55 | 55 | 1-13 | 1-29 | 1-10 | 1 |
| 55 | 109* | 1-13 | 1-56 | 1-17 | 2 & 7 |
| 59 | 59 | 1-14 | 1-31 | 1-10 | 1 |
| 59 | 117 | 1-14 | 1-60 | 1-18 | 3 |
| 61 | 61 | 1-15 | 1-32 | 1-11 | 1 |
| 61 | 121* | 1-15 | 1-62 | 1-18 | 2 & 7 |
| 61 | 122† | 1-15 | 1-62 | 1-18 | 2 & 8 |
| 61 | 183 | 1-15 | 1-93 | 1-27 | 3 |
| 65 | 129* | 1-15 | 1-66 | 1-20 | 2 & 7 |
| 71 | 71 | 1-17 | 1-37 | 1-12 | 1 |
| 71 | 141* | 1-17 | 1-72 | 1-21 | 2 & 7 |
| **Type K Motors** | | | | | |
| 27 | 81 | 1-7 | 1-42 | 1-13 | 3 |
| 27 | 107* | 1-7 | 1-55 | 1-17 | 4 & 7 |
| 29 | 87 | 1-8 | 1-45 | 1-13 | 3 |
| 29 | 115* | 1-8 | 1-59 | 1-17 | 4 & 7 |
| 31 | 93 | 1-8 | 1-48 | 1-19 | 3 |
| 33 | 65* | 1-9 | 1-34 | 1-11 | 2 & 7 |
| 33 | 99 | 1-9 | 1-51 | 1-15 | 3 |
| 33 | 131* | 1-8 | 1-67 | 1-25 | 4 & 7 |
| 35 | 69* | 1-9 | 1-36 | 1-11 | 2 & 7 |
| 37 | 73* | 1-10 | 1-38 | 1-11 | 2 & 7 |
| 37 | 111 | 1-10 | 1-57 | 1-16 | 3 |
| 41 | 81* | 1-10 | 1-42 | 1-11 | 2 & 7 |
| 41 | 123 | 1-10 | 1-63 | 1-18 | 3 |

*One dead coil. †One half-idle bar.

rated at 500 volts, the motor is the one which has the coil pitch of 1 and 13, and the pitch of the leads on the commutator is 1 and 48. This is the data in the eleventh line of Table V.

The last column in the table tells which one of the drawings on this page should be consulted. In these drawings the coil pitch is shown as *A-C*. The commutator pitch is shown as *C-F* and throw of the bottom leads is *C-P*. The drawings show how the various coils are placed in the slots and connected to the commutator. Drawing No. 1 is employed for an armature having the same number of bars as slots, that is one coil to a cell. Drawing No. 2 is used where there is one less than twice as many bars as slots, and one dead coil. Drawing No. 3 shows three times as many bars as slots; drawing No. 4 four times as many,

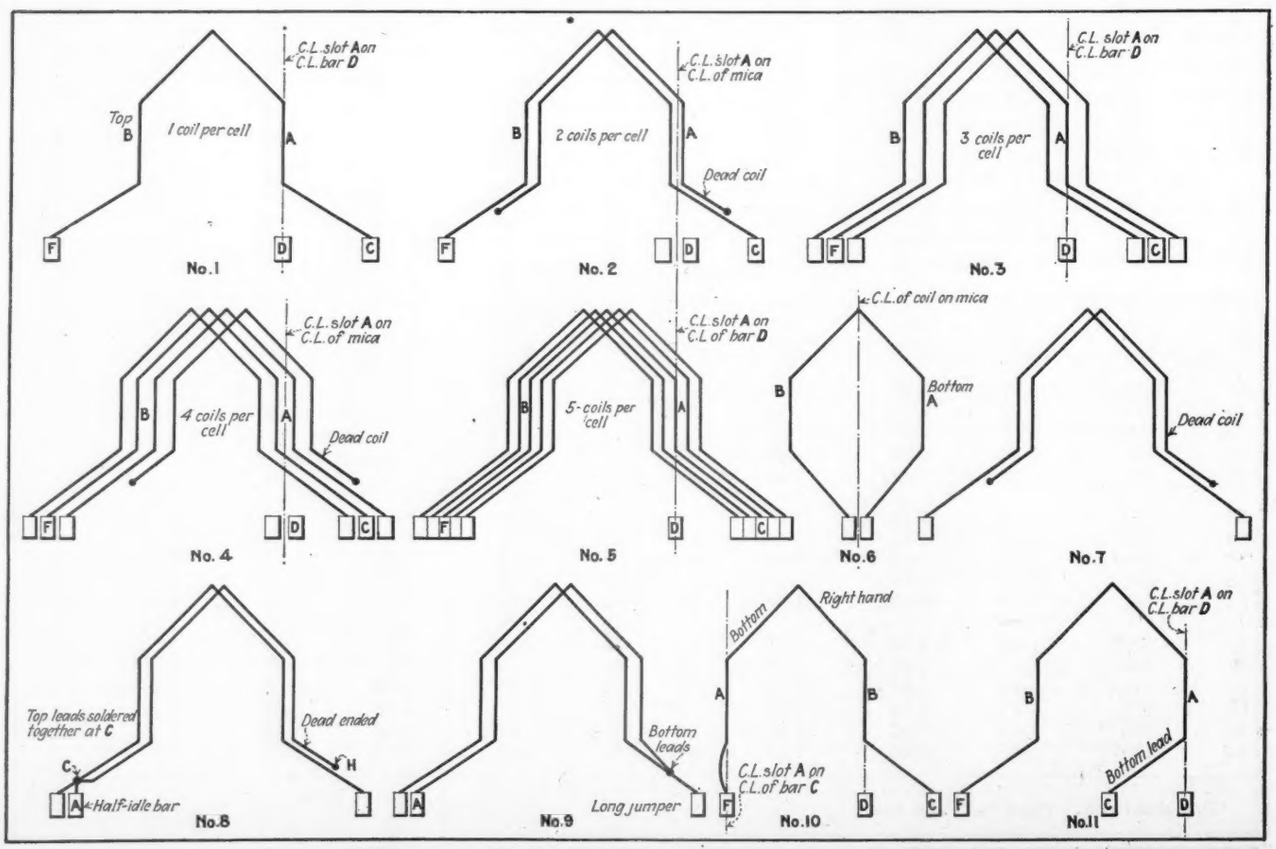
**How lead throw is measured on various direct-current coils.**

These are the drawings referred to in the tables accompanying this article. No. 6 alone refers to a lap winding and all the others to wave windings. The drawings show how the commutator bars line up with the slot holding the bottom of a coil. No. 7 shows a dead coil. No. 8 shows a bar which is "half-idle," that is, only one lead is connected to it. This is the top lead which is attached also to the adjacent coil at *C*. Sometimes the same result is accomplished as in No. 9. Here the bar *A* is again the half-idle bar. No. 11 is for a General Electric "1000" motor.

## Table III—Connecting Data of Old Types of General Electric Motors

| *Frame Number* | *Number Slots* | *Number of Commutator Bars* | *Coil Pitch, A-B* | *Commutator Pitch, C-F* | *Throw of Lead, C-D* | *Refer to Drawing Numbers* |
|---|---|---|---|---|---|---|
| 800 | 105 | 105 | 1-27 | 1-53 | 1-27 | 9 |
| 1200 | 105 | 105 | 1-27 | 1-53 | 1-27 | 9 |
| 1000 | 93 | 93 | 1-24 | 1-47 | 1-13 | 10 |
| 50 | 105 | 105 | 1-27 | 1-53 | 1-27 | 9 |
| 51A | 37 | 111 | 1-10 | 1-56 | 1-15 | 10 |
| 52 | 29 | 87 | 1-8 | 1-44 | 1-12 | 3 |
| 53 | 37 | 111 | 1-10 | 1-56 | 1-29 | 9 |
| 53 | 33 | 99 | 1-9 | 1-50 | 0 | 9 |
| 54 | 29 | 115* | 1-8 | 1-58 | 1-15 | 4 |
| 55 | 47 | 141 | 1-12 | 1-71 | 1-14 | 3 |
| 57 | 37 | 111 | 1-10 | 1-56 | 1-15 | 3 |
| 57 | 33 | 99 | 1-9 | 1-50 | 1-13 | 3 |
| 58 | 33 | 99 | 1-9 | 1-50 | 1-13 | 3 |
| 60 | 37 | 111 | 1-10 | 1-56 | 1-15 | 3 |
| 61 | 41 | 123 | 1-11 | 1-62 | 1-16 | 3 |
| 65 | 55 | 165 | 1-14 | 1-83 | 1-19 | 3 |
| 66 | 39 | 195 | 1-10 | 1-98 | 1-17 | 5 |
| 67 | 37 | 111 | 1-10 | 1-56 | 1-15 | 3 |
| 70 | 37 | 111 | 1-10 | 1-56 | 1-16 | 3 |
| 73 | 39 | 117 | 1-10 | 1-59 | 1-12 | 3 |
| 74 | 39 | 117 | 1-10 | 1-59 | 1-16 | 3 |
| 80 | 37 | 111 | 1-10 | 1-56 | 1-16 | 3 |

*Has one dead coil.



and No. 5 five times as many. All of the coils shown except No. 6 are for wave-wound armatures. No. 6 is a lap-wound coil. No. 7 shows how a dead coil is indicated. The first coil to the right of the first group is taken as the dead coil.

Drawing No. 8 shows how to connect a half-idle bar. It is connected to only one coil. Therefore it must be tied to an adjacent bar. The other end of the coil which connects to this half-idle bar is dead-ended. Such a half-idle bar might be employed for instance where there were 47 slots and 94 bars. In such a case there is one bar too many to give the proper winding. The bottom lead therefore is cut off as shown at *H*, of No. 8, and the end is taped. Then the top leads are soldered together as shown at *C*, and these leads are then brought out to their respective commutator bars. Bar *A* should then only have one lead, which is a top lead, attached to it. This makes this bar alive so that commutation will be satisfactory.

There is another way of doing this. Instead of soldering the top leads together as at *C*, the bottom lead is cut off and soldered to the adjacent bottom lead as shown in No. 9. The two top leads are then put in their respective commutator bars.

Drawing No. 10 shows a coil which has all its throw in its bottom lead. The top lead is connected straight out to a commutator bar. Drawing No. 11 shows the bottom lead bent in towards the center of the coils while the top lead has an extra long throw.

## Table IV—Connecting Data for Westinghouse Types R and Railway Motors

| Frame Number | Number Slots | Number of Commutator Bars | Coil Pitch, A-B | Commutator Pitch, C-F | Throw of Bottom Lead, C-D | Refer to Drawing Numbers |
|---|---|---|---|---|---|---|
| **Type R Motors** | | | | | | |
| 2† | 12 | 36 | 1-6 | 1 & 2 | ..... | 9 |
| 3† | 18 | 54 | 1-9 | 1 & 2 | ..... | 9 |
| 4† | 20 | 40 | 1-10 | 1 & 2 | ..... | 9 |
| 5 | 31 | 93 | 1-8 | 1-48 | 1-19 | 3 |
| 5 | 31 | 123* | 1-8 | 1-63 | 1-19 | 4 & 7 |
| 6 | 35 | 105 | 1-9 | 1-54 | 1-16 | 3 |
| 6 | 35 | 139* | 1-9 | 1-71 | 1-21 | 2 & 7 |
| 7 | 37 | 111 | 1-9 | 1-57 | 1-17 | 3 |
| 7 | 37 | 147* | 1-9 | 1-75 | 1-23 | 4 & 7 |
| 7 | 41 | 81* | 1-10 | 1-42 | 1-13 | 2 & 7 |
| 7 | 41 | 123 | 1-10 | 1-63 | 1-19 | 3 |
| 8 | 37 | 111 | 1-9 | 1-57 | 1-17 | 3 |
| 8 | 37 | 147* | 1-9 | 1-75 | 1-23 | 4 & 7 |
| 8 | 41 | 81* | 1-10 | 1-42 | 1-13 | 2 & 7 |
| 8 | 41 | 123 | 1-10 | 1-63 | 1-19 | 3 |
| **Railway Motors** | | | | | | |
| 3 | 95 | 95 | 1-25 | 1-49 | 1-13 | 1 |
| 12A | 47 | 93* | 1-12 | 1-48 | 1-14 | 2 & 7 |
| 49 | 59 | 117* | 1-14 | 1-60 | 1-18 | 2 & 7 |
| 68-68C | 55 | 109* | 1-14 | 1-56 | 1-16 | 2 & 7 |
| 56-81 | 39 | 117 | 1-10 | 1-60 | 1-17 | 3 |
| 38-38B | 45 | 135 | 1-11 | 1-69 | 1-20 | 3 |
| 50L | 55 | 165 | 1-13 | 1-84 | 1-25 | 3 |
| 101B | 37 | 111 | 1-10 | 1-56 | 1-15 | 3 |
| 69 | 35 | 105 | 1-10 | 1-54 | 1-14 | 3 |
| 76 | 39 | 117 | 1-10 | 1-60 | 1-17 | 3 |
| 85 | 39 | 117 | 1-10 | 1-60 | 1-17 | 3 |
| 89 | 45 | 135 | 1-11 | 1-69 | 1-20 | 3 |
| 92A | 41 | 123 | 1-10 | 1-62 | 1-18 | 3 |
| 93A | 45 | 135 | 1-11 | 1-69 | 1-20 | 3 |
| 112 | 45 | 225 | 1-11 | 1-113 | 1-32 | 5 |

*Armature has one dead coil. †Hand-wound two-pole motors.

# New Products Made In 1922

(*Continued from page* 97)

charger is furnished a switchboard which is equipped with two ammeters, voltmeter, rheostat and reversing switch. For filling storage Battery Company, Philadelphia, Pa., has developed the filler shown in *H* of Fig. 4. The end of the filler is inserted in the cell and the trigger is held down until a small electric bulb lights, as a signal that the cell is full.

A line of stills for making distilled water has been developed by the Barnstead Still & Sterilizer Corporation, Boston, Mass. The stills are made in capacities of from 1 to 3 gal. per hour and are heated by either gas or electricity. An instrument for making with one hand a high-rate discharge test on storage battery cells has been developed by the Service Station Supply Company, Detroit, Mich. This instrument is shown in *I* of Fig. 4. The same company is manufacturing an electrically heated knife operated on 6 volts, for removing sealing compound and also for resealing.

Among equipment which may be classed as signal apparatus is a new combined watchman and fire-alarm system devised by Edwards & Company, Inc., New York, N. Y. The box is so designed that the watchman on his rounds puts a key in each station which rings a bell and makes a record at the superintendent's office. To turn in the fire alarm, the box is operated in the usual way by breaking the glass and pulling a lever. Another interesting development by the same company is a single-stroke bell for alternating current. A new porcelain bell-ringing transformer has been developed by the Dongan Electric Company, Detroit, Mich.

An important development in the lighting field is a portable light meter for the measurement of foot-candles which is being manufactured by Keuffel & Esser Company for the Holophane Glass Company, New York City. This meter is said to give quick and accurate measurements. W. N. Matthews & Bro., St. Louis, Mo., have brought out a new portable lamp guard which shows especially rugged features.

The mill-type lamp which was

developed in the latter part of 1919 is now produced in the following standard sizes: 25 and 50 watts for 115 volts, 50 watts for 230 volts and 275 volts. The 275-volt lamp is designed for mine lighting service.

The mill-type lamp in the 100-volt range is four or five times stronger than the regular Mazda B lamp in its ability to resist sudden shocks, etc. In the 200-volt range the lamp is about three times as strong as the regular Mazda B lamp.

Mill-type lamps have been successfully used in installations which are subject to severe shocks, and other installations where lamp strength is of greater importance than operating efficiency. They have also proved successful in a few rather unusual installations. An example of this is the use of mill-type lamps as headlights in mine locomotives, where a high voltage lamp is required. The mill-type lamps are not quite as efficient from an illuminating standpoint as are the regular Mazda B lamps, producing about 10 per cent less light than the corresponding regular lamp. This difference in illumination is due to the fact that some efficiency has been sacrificed to produce the strength feature.

Mill-type lamps are manufactured by the Westinghouse Lamp Company, the Edison and National Divisions of the General Electric Company. A few of the independent lamp companies also make these lamps.

### Indicating and Testing Instruments

Among the important developments in instruments is one for measuring the insulation resistance of electrical machinery and cables. The resistance is read directly on a scale when a crank is turned at 80 r.p.m. The energy is furnished by a small 500-volt direct-current generator. A new line of direct-current instruments having a D'Arsonval movement has been completed by the Westinghouse Electric & Manufacturing Company. These are made in a variety of sizes and types for portable use and for mounting on switchboards, walls, tables and so on. The company states that an improved method of treating magnets has been developed which makes them practically free from changes. A corresponding line of alternating-current instruments is being placed on the market by the same company. A small ammeter, having no coils nor terminals, was also developed by this company. The current indications are obtained by passing the conductor through a loop of magnetic material at the back of the case.

The Westinghouse Electric & Manufacturing Company and the General Electric Company have developed for use at industrial plants small lightning arresters which contain no liquid electrolyte; the electrolyte is made of solid material.

A new type of ball bearing has been developed by Standard Steel

## Table V—Data on Old Types of Railway, Crane, Mining and Mill-Type Westinghouse Motors

*This table accompanies the article on page 98*

| Frame Number | Voltage | Number Slots | Number Commutator Bars | Coil Pitch, A-B | Commutator Pitch, C-F | Number Turns per Coil | Number Wires per Turn | Size and Kind of Wire |
|---|---|---|---|---|---|---|---|---|
| 0 | 220 | 23 | 115 | 1-6 | 1-59 | 1 | 1 | 1/16 in. x 3/16 in. Strap |
| 00 | 220 | 25 | 75 | 1-7 | 1-39 | 4 | 1 | No. 10 DCC |
| 000 | 220 | 29 | 87 | 1-8 | 1-45 | 6 | 1 | No. 14 DCC |
| 1 | 220 | 33 | 99 | 1-8 | 1-51 | 2 | 1 | .0808 in. x .200 in. DCC Ribbon |
| 2 | 220 | 31 | 155 | 1-8 | 1-79 | 1 | 1 | .058 in. x .400 in. DCC Ribbon |
| 3 | 220 | 45 | 135 | 1-11 | 1-69 | 1 | 1 | 3/32 in. x ½ in. Strap |
| 4 | 220 | 41 | 123 | 1-11 | 1-63 | 1 | 1 | 3/32 in. x ⅝ in. Strap |
| 4 | 220 | 45 | 180§ | 1-12 | 1-2 | 1 | 1 | 5/64 in. x ½ in. Strap |
| 6 | 220 | 39 | 156§ | 1-11 | 1-2 | 1 | 1 | 7/64 in. x ⅝ in. Strap |
| RWY 3 | 500 | 95 | 95 | 1-25 | 1-49 | 4 | 1 | No. 11 DCC |
| 12 | 500 | 47 | 93* | 1-13 | 1-48 | 4 | 1 | No. 10 DCC |
| 12 | 500 | 47 | 93* | 1-13 | 1-48 | 5 | 1 | No. 11 DCC |
| 12A | 500 | 47 | 93* | 1-12 | 1-48 | 5 | 1 | No. 10 DCC |
| 12A | 500 | 47 | 93* | 1-11 | 1-48 | 4 | 1 | No. 10 DCC |
| 12A | 250 | 47 | 93* | 1-11 | 1-48 | 2 | 1 | No. 10 DCC |
| 38B | 500 | 45 | 135 | 1-11 | 1-69 | 2 | 1 | No. 9 DCC |
| 38B | 250 | 45 | 135 | 1-11 | 1-69 | 1 | 2 | No. 9 DCC |
| 39 | 220 | 47 | 94† | 1-12 | 1-48 | 1 | 1 | ⅛ in. x ½ in. Strap |
| 39 | 220 | 47 | 141 | 1-12 | 1-72 | 1 | 1 | ⅛ in. x ½ in. Strap |
| 39 | 220 | 55 | 110† | 1-13 | 1-56 | 1 | 1 | ⅛ in. x ½ in. Strap |
| 49 | 500 | 59 | 117* | 1-14 | 1-60 | 3 | 2 | No. 9 DCC |
| 50A | 550 | 55 | 165 | 1-13 | 1-84 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 50E | 500 | 55 | 165 | 1-13 | 1-84 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 50E | 220 | 52 | 156§ | 1-13 | 1-2 | 1 | 1 | 5/64 in. x ¾ in. Strap |
| 50F | 250 | 55 | 165 | 1-13 | 1-84 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 50D | 220 | 55 | 110† | 1-13 | 1-56 | 1 | 1 | ⅛ in. x ⅝ in. Strap |
| 50L | 500 | 55 | 165 | 1-13 | 1-84 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 38B | 220 | 45 | 135 | 1-11 | 1-69 | 1 | 1 | 1/16 in. x 7/16 in. Strap |
| 54 | 220 | 47 | 93* | 1-12 | 1-48 | 4 | 1 | No. 9 DCC |
| 56 | 500 | 39 | 117 | 1-10 | 1-60 | 2 | 3 | No. 10 DCC |
| 56A | 220 | 39 | 117 | 1-10 | 1-60 | 1 | 1 | 1/16 in. x ⅝ in. Strap |
| 57 | 500 | 39 | 117 | 1-10 | 1-60 | 3 | 2 | No. 11 DCC |
| 57 | 250 | 47 | 93* | 1-12 | 1-48 | 2 | 2 | No. 8 DCC |
| 58 | 500 | 35 | 105 | 1-9 | 1-54 | 4 | 1 | No. 9 DCC |
| 58 | 220 | 35 | 105 | 1-9 | 1-54 | 2 | 2 | No. 9 DCC |
| 59 | 500 | 35 | 105 | 1-9 | 1-54 | 5 | 1 | No. 10 DCC |
| 59 | 220 | 39 | 117 | 1-9 | 1-60 | 2 | 3 | No. 10 DCC |
| 60 | 500 | 35 | 105 | 1-9 | 1-54 | 6 | 1 | No. 12 DCC |
| 60 | 220 | 35 | 69* | 1-9 | 1-36 | 4 | 1 | No. 9 DCC |
| 61 | 500 | 39 | 117 | 1-10 | 1-60 | 7 | 1 | No. 14 DCC |
| 61 | 220 | 39 | 77* | 1-10 | 1-40 | 5 | 1 | No. 10 DCC |
| 62 | 500 | 39 | 117 | 1-10 | 1-60 | 2 | 3 | No. 10 DCC (same as No. 56) |
| 64 | 500 | 35 | 105 | 1-9 | 1-54 | 10 | 1 | No. 15 DCC |
| 64 | 220 | 39 | 77* | 1-10 | 1-40 | 6 | 1 | No. 12 DCC |

*Armature has one dead coil, Drawing No. 7. †Commutator has one half-idle bar, Drawing No. 8. ‡Split pitch. §Lap wound, Drawing No. 6.

Bearings, Inc., Philadelphia, Pa. In this bearing the inner and outer races have two deep ball grooves. The groove curvatures correspond to the contour of the balls. A new type of key for pulleys and the like has been developed by Smith & Serrell, Newark, N. J. This key has two sharp corners cut at one end and is driven in so that it cuts the shaft and pulley away and thus insures a perfect fit.

Among the advances which have been made in electric heating is the electric steam generator. The generation of steam by passage of electrical current through it is coming into use in a number of applications in this country. Two examples of boilers for this purpose are shown at the left and the center of Fig. 8. Such boilers have proved successful under a number of different conditions. They may be employed to make waste power useful in industrial plants which have their own water power and generating equipment, where steam is needed during Sundays and holidays. When an industrial concern buys its power on a fixed annual charge under a certain maximum, it is sometimes impossible to use this maximum amount. During these times the electric boilers might be used to advantage. Where comparatively small amounts of steam are necessary at a considerable distance from the boiler house it will sometimes be found more profitable to transmit the electric power and generate the steam in an electrically heated boiler at the point of utilization. Another application of these boilers which is in use is the case where the central power station installs and maintains a boiler in an industrial plant and sells the energy on the basis of metered steam. Among the companies making such steam boilers are the General Electric Company, Schenectady, N. Y., and the Electric Furnace Construction Company, Philadelphia, Pa. The latter company has installed thirteen of these boilers during 1922, ranging in size from 3 boiler hp. to 1,800 boiler hp. and from 30 kw. to 18,000 kw. In one installation made by this company at the Laurentide Paper Company one man is operating two boilers with a capacity of 30,000 kw., equivalent to a total of 6,000 boiler hp. Slightly over 3,000 lb. of steam can be generated per kilowatt-hour and the actual operating efficiency usually runs around 98 per cent. The steam pressure in these boilers is dependent upon the customers' requirements, but the majority of the large boilers in various plants are operating at 120 to 150 lb. pressure.

The largest steel furnace yet installed is the 60-ton furnace of 12,000-kw. capacity for the new Ford plant at River Rouge. This furnace, which was made by the Electric Furnace Construction Company, is equipped with eight electrodes and the power can be fed either entirely through (*Continued on page* 118)

## Table V Continued—Data on Old Types of Railway, Crane, Mining and Mill-Type Westinghouse Motors

*This table accompanies the article on page 98*

| *Frame Number* | *Voltage* | *Number Slots* | *Number Commutator Bars* | *Coil Pitch, A-B* | *Commutator Pitch, C-F* | *Number Turns per Coil* | *Number Wires per Turn* | *Size and Kind of Wire* |
|---|---|---|---|---|---|---|---|---|
| 65 | 500 | 39 | 117 | 1-10 | 1-60 | 6 | 1 | No. 11 DCC |
| 65 | 220 | 35 | 105 | 1-9 | 1-54 | 3 | 2 | No. 10 DCC |
| 66 | 500 | 39 | 117 | 1-10 | 1-60 | 9 | 1 | No. 14 DCC |
| 66 | 220 | 47 | 93* | 1-11 | 1-48 | 5 | 1 | No. 10 DCC |
| 67 | 500 | 37 | 111 | 1-9 | 1-57 | 7 | 1 | No. 13 DCC |
| 67 | 220 | 37 | 73* | 1-9 | 1-38 | 5 | 1 | No. 10 DCC |
| 68 | 550 | 55 | 109* | 1-14 | 1-56 | 3 | 2 | No. 12 DCC |
| 69 | 500 | 35 | 105 | 1-10 | 1-54 | 4 | 1 | No. 10 DCC |
| 73 | 500 | 39 | 117 | 1-10 | 1-60 | 9 | 1 | No. 15 DCC |
| 73 | 220 | 35 | 105 | 1-9 | 1-54 | 5 | 1 | No. 11 DCC |
| 75 | 500 | 35 | 105 | 1-9 | 1-54 | 5 | 1 | No. 10 DCC |
| 75 | 220 | 39 | 117 | 1-10 | 1-60 | 2 | 3 | No. 10 DCC |
| 76 | 500 | 39 | 117 | 1-10 | 1-60 | 2 | 3 | No. 9 DCC |
| 76 | 220 | 31 | 93 | 1-9 | 1-48 | 1 | 1 | 1/10 in. x ⅝ in. Strap |
| 76A | 220 | 39 | 117 | 1-10 | 1-60 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 79 | 500 | 35 | 105 | 1-9 | 1-54 | 4 | 2 | No. 12 DCC |
| 83 | 600 | 49 | 196† | 1-12 | 1-99 | 1 | 1 | 3/64 in. x ⅝ in. Strap |
| 85 | 500 | 39 | 117 | 1-10 | 1-60 | 2 | 2 | No. 9 DCC |
| 86 | 570 | 53 | 159 | 1-13 | 1-81 | 1 | 1 | ⅛ in. x 7/16 in. Strap |
| 89 | 500 | 45 | 135 | 1-11 | 1-69 | 2 | 3 | No. 10 DCC |
| 92A | 550 | 41 | 123 | 1-10 | 1-62 | 3 | 1 | No. 10 DCC |
| 92A | 220 | 45 | 135 | 1-11 | 1-68 | 1 | 1 | 3/32 in. x ½ in. Strap |
| 93A2 | 550 | 45 | 135 | 1-11 | 1-69 | 2 | 2 | No. 10 DCC |
| 95 | 500 | 37 | 111 | 1-10 | 1-57 | 3 | 1 | No. 9 DCC |
| 96 | 220 | 52 | 156§ | 1-13 | 1-2 | 1 | 1 | 5/64 in. x ¾ in. Strap |
| 101B | 500 | 37 | 111 | 1-10 | 1-56 | 3 | 1 | No. 9 DCC |
| 101D2 | 500 | 45 | 135 | 1-11 | 1-69 | 2 | 2 | No. 11 DCC |
| 102A | 500 | 39 | 155* | 1-10 | 1-79 | 2 | 2 | No. 6 DCC |
| 102A | 220 | 27 | 135 | 1-7 | 1-69 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 101K | 500 | 25 | 125 | 1-7 | 1-63 | 4 | 1 | No. 10 DCC |
| 115 | 250 | 47 | 93* | 1-12 | 1-48 | 2 | 2 | No. 8 DCC |
| 109 | 500 | 55 | 165 | 1-13 | 1-84 | 1 | 1 | 5/64 in. x ⅝ in. Strap |
| 112 | 550 | 45 | 225 | 1-11 | 1-113 | 1 | 1 | 3/64 in. x ½ in. Strap |
| 113 | 550 | 31 | 155 | 1-8-9‡ | 1-78 | 1 | 1 | ⅛ in. x ½ in. Strap |
| 119 | 500 | 37 | 185 | 1-10 | 1-94 | 1 | 1 | 1/16 in. x ⅝ in. Strap |
| 121A | 500 | 41 | 205 | 1-11 | 1-104 | 1 | 1 | 3/64 in. x ⅝ in. Strap |
| 122 | 500 | 47 | 188† | 1-8 | 1-64 | 2 | 2 | No. 8 DCC |
| 122 | 220 | 43 | 172† | 1-8 | 1-58 | 1 | 1 | 3/64 in. x ⅝ in. Strap |
| 131 | 500 | 39 | 117 | 1-10 | 1-60 | 5 | 1 | No. 11 DCC |
| 131 | 220 | 35 | 69* | 1-9 | 1-36 | 4 | 1 | No. 7 DCC |
| 155 | 220 | 35 | 69* | 1-9 | 1-36 | 4 | 1 | No. 7 DCC |
| 158 | 250 | 40 | 160† | 1-8 | 1-54 | 1 | 1 | 1/16 in. x ⅝ in. Strap |
| 230 | 500 | 41 | 123 | 1-10 | 1-63 | 2 | 2 | No. 9 DCC |

*Armature has one dead coil, Drawing No. 7. †Commutator has one half-idle bar, Drawing No. 8. ‡Split pitch. §Lap wound, Drawing No. 6.

# INDUSTRIAL ENGINEER

*Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories*

DANIEL H. BRAYMER
*Editorial Director*

*Assisted by*

G. A. VAN BRUNT E. H. HUBERT F. E. GOODING


Chicago, February, 1923

## *Why Not Make the Hard Job Easy?*

A MAN who has had long and varied experience in maintenance work was once asked how he overcame any tendency on the part of his men to neglect inspection of inaccessible motors and equipment, and in general to slight the hard jobs. "There aren't any hard jobs around here," he replied. "I make it my business to see that the men are given the proper equipment and facilities for making every job an easy one."

His statement expresses a truth that is often overlooked. Usually the main difference between an easy job and a hard one lies in the availability or absence of the proper facilities for doing the work.

It is rather strange that while every precaution is taken to protect the worker at bench or machine from injury and to help him in all practicable ways, in many cases little or no attempt is made to lighten or make less hazardous the work of the inspector or maintenance man. Cleaning lamps and inspecting or repairing equipment which is mounted overhead or in other hard-to-reach places, is hard work in that a good deal of physical exertion is required, and in addition there is always present more or less risk of injury from falls or other mishaps.

Permanent ladders or even rungs attached to building columns, walls or elsewhere, will make climbing up and down both easier and safer. Or an ordinary ladder may be hung in some convenient place and thus relieve the inspector of the necessity of carrying it with him. Likewise, small platforms with guard rails will provide a safe place to stand while inspection or repair work is being done on equipment mounted overhead. But better still is the plan of considering maintenance when the installation is made and arrange things as accessible and get-at-able for maintenance men as possible.

Shirking hard or dangerous jobs is not necessarily an indication of laziness; it may be merely self-preservation. The most effective remedy for it is to make the so-called hard jobs easy by eliminating so far as possible the dangerous or disagreeable features.

## *Where Do Dividends Come From?*

A CAREFUL study of the source of profits usually shows that they can be traced in many cases to reclaimed wastes. "Everyday operation and production pays the expenses but the profits come from the reduced junk pile," is the way one large manufacturer expresses it. But more than wasted material goes into the junk pile; it contains in addition, hours of labor of men and machines as well as the time and attention of the yard and shop gangs engaged in the miscellaneous handlings through which it passes.

For years most of the managerial attention has been directed toward increasing the productive value of men and machines and ignoring the tremendous wastes of large gangs of men engaged in miscellaneous handling routine. That it is profitable to make these studies and changes is well shown by a recapitulation of some of the examples already given in the "Handling Materials" section of the INDUSTRIAL ENGINEER. For example, on page 64 of the January, 1923, issue, the story of a $21,000 a year saving is told. The necessary additional equipment, a special roll paper storage battery truck, which cost only a few thousand dollars, has repaid its initial cost several times over. In another instance (page 552, November, 1922) a traveling crane and magnet over a scrap iron yard saved $1,000 a year by eliminating the cost and maintenance of wheelbarrows alone. In addition, cars could be loaded better, more quickly and at less expense than by hand labor.

Other instances of savings recorded are: Doubling storage capacity by piling higher and at less expense through doing it mechanically; doubling the productive capacity by a conveyor installation; cutting in half the cost of handling coal to and from storage, and also of charging and discharging malleable furnaces. Many more illustrations are given in this department; in some cases, however, the new method did the former task so quickly that it took on additional duties and so made the actual savings difficult to estimate.

In all of these instances the waste of time and money had been going on for years. In contrast the savings will continue indefinitely or until superseded by other methods more economical. Does the elimination of these wastes pay dividends? The saving of $21,000 a year will pay 6 per cent on $350,000. Companies that are prosperous pay dividends and usually are more liberal with wages and salaries, too.

## *Do You "Shop" for a Spool of Thread?*

NO doubt those who read what follows have laughed over the story of the frugal housewife who paid carfare from her home in a distant part of a city to a large drygoods store and return, to buy a spool of thread because it was a cent cheaper than at the little shop just around the corner. But it's not such a joke as it may seem for many of us might question our own personal practice in applying such economy to our purchasing methods.

In a recent study of some purchasing methods of various companies, a circumstance involving a similar expenditure with little economy was discovered. The purchasing department of a concern had the hard and

fast rule of making inquiries and receiving quotations on every article purchased. In this case, the purchasing department actually sent out inquiries to six different concerns for quotations on one cast-iron collar for a lineshaft, the total value of which would be about 30 cents. The cost of the six letters, which are generally figured at about 25 cents apiece, the time spent in receiving and tabulating the replies, and the time which must be given to interviewing salesmen who, with a lead of this sort, would inevitably call, would total many times the original cost of the collar. This would also take time and delay the work of the maintenance department in its installation. This is not an exaggerated condition but actually happened and it is unfortunate, but true, that this or a closely related practice is not hard to find in many organizations.

Some concerns have eliminated much of this needless waste through dealers who can supply from stock any of the miscellaneous pulleys, belts, bolts, or other mill supplies which may be necessary. If in a hurry orders are issued over the telephone and confirmed later or a messenger is sent directly to the supply house with an order and waits till it is filled. "Shopping" frequently saves money, but usually its main function is to indicate the best place to buy.

### *Learning a Trade vs. Holding a Job*

WE recently received a letter from the chief electrician of a large paper mill in which the following comment was made: "Another point that I wish to bring out is the attitude of a great many men today, especially young fellows starting in, that they are holding a job and not learning a trade, but believe their promotion should come because they are in line for the next job."

Many men who graduate from an engineering school sort of back into practical work. That is to say, they have a little better opinion of their ability than anyone else and fasten their eyes on a position while their back is turned on their opportunity and they must either be pushed into it or stumble into it. Most of the men with degrees from engineering schools who have gone ahead fastest in practical work are those who have shown a willingness to start at the bottom and dig their way up with their eyes, their hands and their ingenuity. They have not assumed a know-it-all attitude and have used their college training simply as a tool in the analysis of the work they have to do. They have studied the methods of older practical men and learned a lot from them, they have analyzed their work from the standpoint of its effectiveness and costs, and they have never refused to undertake a thing that might soil their hands or hurt their pride. They have dug-in and in many cases where promotion has come by reason of this attitude and the results shown, they have given up the old work for the new with some reluctance because they were in love with it. But in the new work they have dug in again and so have gone on and up.

This is not only true of young college men for many men who never sat in the halls of higher learning have followed this kind of procedure and by self study and initiative have mounted to places that others with college training have failed to secure. Any man who makes up his mind to learn one or more trades and shows an ambition to get ahead will never have to wait for dead men's shoes. Men in industrial works are looking for just such young men and opportunities for promotion are frequently closer than they often know when they show the ability to analyze themselves as well as the work they are given to do.

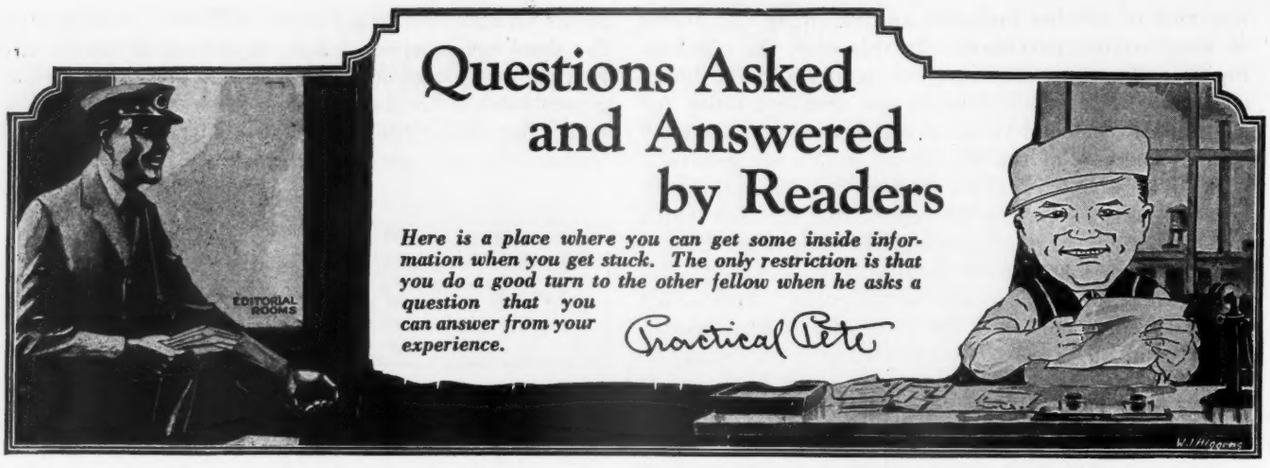
### *Light Is Needed Two Hours Every Day*

NOW that the working day begins to have more hours of daylight, the tendency is to postpone needed improvements in illumination to which the darker days have called attention. Even in summertime in buildings where good use is made of daylight illumination, there is in particular departments at times a dependence upon artificial illumination. When it is not provided, the speed of production automatically slows down with the result that the actual hours of maximum production are reduced.

If, therefore, the past few months have shown a need for better artificial illumination, this need can be supplied with profit before the longer use of lamps each day comes up next fall. And there is a need for better lighting in many plants. This was shown through details of a report presented recently by W. H. Rademacher of the Edison Lamp Works before the Illuminating Engineering Society. In that report Mr. Rademacher made the following comment:

"Manufacturing buildings are invariably constructed so that the maximum amount of daylight illumination is insured, it apparently being realized that daylight illumination of a high order is well worth having. It seems almost paradoxical then that a good many of these plants which are so well fortified from the daylight manufacturing standpoint have artificial lighting systems which may be considered far from adequate. Artificial light by many still seems to be considered a necessary evil and lighting systems under these conditions are merely the application of a lamp bulb, as such, rather than the procurement of real illumination. * * * * When we remember that in the so-called daylight industries there are approximately 300 working days per year in which there is an average of 2 hours per day during which artificial light is required, we can quite fully appreciate that really good artificial light is essential and has a bearing on the plant's successful operation."

In making a check on lighting conditions it is recommended in the above-mentioned report that attention should be given to the following points: (a) General character of building; (b) analysis of the processes of manufacturing; (c) present lighting practice; (d) recommended practice as to intensity, type of equipment and method of lighting; (e) special or peculiar lighting requirements. Whether or not the lighting of a plant is adequate, an inspection covering these points by the maintenance department as a regular procedure a couple of times a year will provide useful information when changes or additions in plant departments are being made and at the same time serve as effective checks on the illumination requirements to best suit production conditions. When a new lighting system is installed it does not follow that it will be adequate for all time, especially when changes in operating processes are frequent and the character of product worked on changes from time to time. Definite checks should be made on lighting to insure that all the energy converted into light is used and not wasted and for the same reasons that checks are made on the effective use of any other raw material required in the product.




# Questions Asked and Answered by Readers

*Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.*

## Who Can Answer These?

**Origin of the Name "Bug"**—Can you explain in the columns of INDUSTRIAL ENGINEER when and where the expression "the bug in the circuit" arose? I presume it comes down from the telegraph days. I would like to hear from some of the old-timers on this point.
Raleigh, N. C. W. H. B.

* * * *

**Size of Pulley on a Motor**—The writer would like to request readers of INDUSTRIAL ENGINEER to indicate what is considered good practice in the dimensions of pulleys for d. c. and a. c. motors. For instance, is it good practice to use a pulley larger than the diameter of the armature? If not, why?
Orange, N. J. R. H. S.

* * * *

**Changing Speed of Single-Phase Motor**—I have recently had trouble with a single-phase, 3-hp., 1200 r.p.m. motor which was marked Variable Speed on the nameplate. This motor has four brushes, two on compensating winding and two on the main winding, but seems to be a six-pole design. I would like to know how this motor can be changed to get a variation in speed.
Kings Park, N. Y. N. J. W.

* * * *

**Trouble with Motor Generator**—We have a 175-kva. motor generator set which is giving us trouble. The motor is a synchronous type operated at 2,200 volts. The generator is direct connected and produces 250 volts, d. c. The trouble we are having is with the a. c. motor. The stator and rotor of this machine have been rewound six times during the last year and a half. It carries a load of about two-thirds capacity but must and does handle 50 per cent overload for about two minutes over fifteen-minute periods. The generator is handling a load of mine locomotives and the overload occurs when the locomotives are taking the crest of a grade. However, the temperature rise of the machine at the end of a day's run is not higher than allowed by the manufacturer. The machine seems to be O. K. until it lets go, there being no evidence of slowing down. So far as we can ascertain, it seems as though the pole face winding gives way and this rips up both stator and rotor. The d. c. generator will not over-compound, even with all the shunt field cut out. I would like to see some explanation of the cause and remedy for this trouble.
Vincennes, Ind. T. J.

* * * *

**Changing D. C. Motor to a Generator**—We have a d. c. Holtzer-Cabot motor with the nameplate rating and armature construction as follows: 120 volts, 2.7 amp., ¼ hp., 675 r.p.m., 2-pole, shunt wound. The armature has 18 slots and 36 coils. The coil span is 1 to 9. One coil has 26 turns of No. 33 d.c.c wire. The armature is lap wound. The field winding has 2,100 turns of No. 25 s.c.c wire. There are two poles. We desire to use this motor as a direct-current generator at a speed of 1,700 r.p.m, generating 10 volts. Can the rating of the generator be made approximately the same as the motor and what will be the amperage when generating 10 volts? If this change is possible, please give full details with the diagram for rewinding the armature and the fields.
Vallejo, Cal. L. Z.

* * * *

**Correcting Power Factor**—Will some reader of INDUSTRIAL ENGINEER give me information on types of meters and connections for use on a 3-phase, 3-wire, 60-cycle, 240-volt circuit to indicate the power factor of the motor load? At present we are operating two M. G. sets with synchronous motors rated at 225 kva. each. In case these motors are operated at a power factor of 80 per cent, what will be the effect on the power factor of the mill line? Under conditions that cannot be avoided, most of our equipment is over-motored and the power factor is low. To what extent have synchronous motors been used as synchronous condensers, and also to what extent have static condensers been used for conditions such as named?

I would also like to get some information on the use of magnetic clutches and their effectiveness when machines must be started and stopped several times per hour.
Ambridge, Pa. N. H. C.

## Answers Received To Questions Asked

**Crane Collector Wires**—On a five-ton alternating-current crane, having a bridge or cross travel of about 50 feet, we have experienced considerable trouble with the collector wires sparking at the contacts. Both types of collectors have been tried out; namely, shoes and wheels, and we have been forced to use flexible cables to do away with standard collecting devices.

Can readers tell us what the trouble is and how they overcome such difficulties in practice, for we do not feel it should be necessary to resort to the method we have adopted?
New York, N. Y. M. K.

Sparking at crane collector wires may be caused in several ways. On one occasion the writer had considerable trouble on a 550-volt, a. c. crane in a steel foundry. The sparking was always worse near the ends of the wires and was stopped by raising the arm carrying the collector wheels. In the center the weight of the wires caused them to sag a little so that they made pretty fair contact with the wheels under them, but near each end where the wires were supported they were barely touching the wheels.

The arm was reset so that the bottom of the groove on the top side of the wheels was about ⅛ in. above a taut line held underneath and touching the collector wires at both ends immediately next to their points of support. While this gave a good contact, yet it was not tight enough to cause the wheels to bind against the wires near the ends of their travel.

Another fruitful cause of sparking is dirt on the wires. This as well as burned and dirty contacts at the controller will generally cause the motors to run single-phase and

where the designer has not been very liberal as to the size of the collector wires or of the collector wheels or shoes, this will generally cause sparking. Dirt on the wires should be looked for especially after the crane has been under repairs, such as changing bearings, gears, etc., when a lot of dirty grease and oil is often dumped over the sides without much regard for the collector wires.

Again, when using wheels, sparking may be caused by the wheels not turning on their spindles. This causes the wires to cut a groove in the top of the wheels. No trouble will be noticed as long as the wire stays in this groove, but if a sudden jar should shake the wire out of its groove, it might not get down again to the bottom and will make very little contact, thus causing sparking.

A much lower voltage than the motors are designed for will also cause sparking through excessive current. J. H. GALLANT.

Belleville, Ont., Canada.

* * * *

**Making Equipotential Connections**—In the book by D. H. Braymer on Armature Winding and Motor Repair, page 22, the statement is made, "With lap windings, one ring for every 6 to 12 segments is common practice, but this is scarcely feasible when the number of pairs of field magnet poles is greater than the number of sections of armature winding in parallel, for here the potential pitch may be fairly large and the number of rings becomes prohibitive." In the case of a large generator having 200 or more segments we would have a very large number of rings and they would form a bulky mass. I would like to see an explanation of how to make these equipotential connections for a particular case, showing how the taps are made.

Brooklyn, N. Y. I. T.

In the December issue I noticed I. T.'s question regarding equipotential connections which is quite fully answered by A. C. Roe. I would like to call attention, however, to the following. I. T. quotes a statement from D. H. Braymer's book on Armature Winding and Motor Repair which refers to equipotential connections on lap wound armatures and then inquires how this applies to a machine in which the number of pole pairs is greater than the number of armature winding sections in parallel. If that means that the armature is wave wound, then the equipotential connections are not required because in such windings each circuit is equally affected by all poles, and therefore the generated e.m.f.'s must be equal in each armature branch thus eliminating the necessity for using equipotential connections. HENRY H. METZENHEIM.

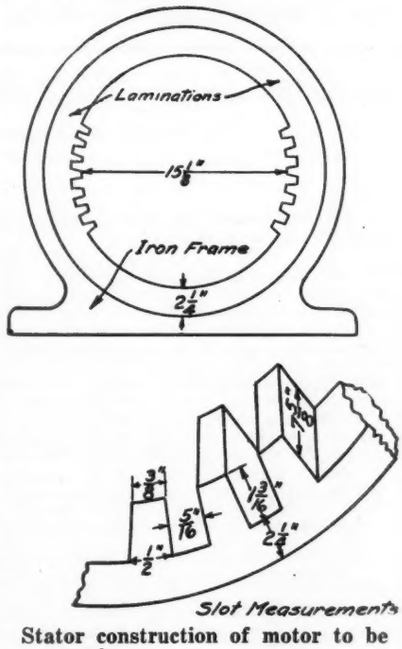
Newark, N.J.

* * * *

**Figuring Horsepower of Motor From Winding Data**—I have a motor with the nameplate taken off so that the rating is not known. Will someone please tell how to figure the horsepower and the ampere rating from the sketch and data which follows?

This motor has been operating on a 440-volt, 3-phase, 60-cycle circuit. The old winding had coils of 7 turns of No. 16 B & S gage wire, 3 wires in parallel. There are 72 slots with 18 pole-phase groups or 6 poles per phase, with a total of 72 coils. The coil pitch is 1 to 11 and the connection is a one-circuit star. The rotor of this motor is bar-wound and not of the slip-ring type.

Wisconsin Rapids, Wis. I. D. K.




**Stator construction of motor to be rewound.**

With regard to I. D. K.'s question regarding how to figure the horsepower of a motor from the winding data, first check the core to determine the allowable horsepower rating as per A. M. Dudley's book on "Connecting Motors" and the Standard Electrical Engineer's Handbook.

According to the figures given, the core is good for 45 to 50 hp. at 12,000 r.p.m. but a 40-hp., 3-phase, 440-volt motor will pull approximately 55 amp. at full load, while a 50-hp. motor will pull 64 amp.

Three No. 16 wires have a total area of $3 \times 2582$ equals 7746 circ. mils. Then with a series-star connection the current per phase is equal to the line current. The circ. mils per amp. for a 40-hp. rating would be $7746 \div 55$ equals 140, approximately, which is too low a value for this size motor. Figuring 325 circ. mils per amp., the winding will be good for approximately 25 amp., or 20 to 25 hp.

Detroit, Mich. A. C. ROE.

* * * *

Regarding I. D. K.'s question in the November issue of INDUSTRIAL ENGINEER, I would advise as follows:

Professor Hobart's formula (H.P. $= K \times D^2L \times R.P.M. \times L$ where K in this case is .00028) gives, approximately, 44 hp.

Professor Gray's formula (H.P. $= D^2L \times 2.35 \times B \times$ eff. $\times$ p.f. $\times$ R.P.M. $\times 10^{-12}$) gives, for a suitable gap density, an efficiency of 0.88 and p.f. 0.85, about 41 hp.

However, with the winding connected one-circuit-star, it is evident that I. D. K. is not getting even 50 per cent of the possible output of the machine, and should reconnect it two-circuit-star. By checking this winding electrically with the two-circuit-star connection and suitable values of circular mils per amp. and ampere conductors per inch, I find that the output is in the neighborhood of 40 hp. which checks very closely with the mechanical calculations mentioned. K. C. GRAHAM.

Buzzell Electric Works,
San Francisco, Cal.

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**Small Condenser for 110-Volt A. C. Circuit.**—I want to make some experiments with condensers on a. c. circuits of 110 volts, the capacity of the condensers to be approximately one microfarad. 1. Where can I obtain the necessary sheets of tin foil? 2. What should I use for the dielectric? 3. Where can I obtain same? 4. What thickness should the dielectric be for 110 volts a. c.? I have never seen any of this material advertised, consequently this request to you.

Logansport, Ind. L. E. G.

In answer to L. E. G. who asks in the November issue of INDUSTRIAL ENGINEER for data on small condensers, I would refer him to the Stromberg-Carlson Telephone Manufacturing Co. of Rochester, N. Y. This company manufactures a line of small, tin-foil condensers, neatly enclosed in insulated sheet metal cases. The condensers range in capacity from 0.4 to 5 m.f., and are tested with a breakdown voltage of 350 volts. They are quite reason-

ably priced and, I believe, ought to be satisfactory for this reader's work. We have used them on 115 volts.

Electrical Engineer, J. M. WALSH.
Gurney Elevator Company,
Honesdale, Pa.

* * * *

Regarding the question by L. E. G. in the November issue, (1) the tinfoil can be obtained from any supply house handling radio supplies; (2) paraffined paper is suitable for the dielectric in condensers for use on 110-volt circuits; (3) the paper can be purchased from the same dealer supplying the foil; (4) the thickness of dielectric necessary depends upon the maximum voltage impressed upon it but 0.015 inch paper is ample. For calculating condensers of a particular capacity, the following formula can be used: $C=(K\times A\times 2248)\div(T\times 10^{10})$, where $C$ equals capacity in mfds.; $K$ equals a dielectric constant (2 for paraffined paper); $A$ equals area of conducting surface and $T$ equals thickness of dielectric in inches.

Detroit, Mich. J. B. RAKOSKE.

* * * *

**Changing Two-Phase Starter for Three-Phase Operation.** — In the August issue A. C. Roe gave a sketch illustrating how a two-phase starter can be connected for three-phase operation. May I ask Mr. Roe if this is not a wiring sketch of a Westinghouse compensator? Will changing of external connections only, hold good on other makes of compensators? M. A. D.
Intercourse, Pa.

While the sketch in question refers to a Westinghouse three-phase auto-starter or compensator used to start an induction motor, it can be changed to operate on two-phase, three or four wire service. If the starter has three coils, all three can be used, or the middle coil can be cut out of circuit.

The principle used is an auto-transformer connected to reduce the voltage applied to the motor terminals. On three-phase starters two coils are used in later types. That is, one in each outside leg. Then if it is desired to use the starter for a two-phase, four-wire circuit, without adding extra contacts, four wires can be brought to the compensator.

As the copper in the coils will not work up to the maximum on two-phase, the starter can be used for a larger two-phase motor; that is, a 20-hp., three-phase starter could be used on a 25-hp., two-phase motor.

Detroit, Mich. A. C. ROE.

**R L M Standard Dome Reflectors.**—We would like to see published in INDUSTRIAL ENGINEER an explanation of what is meant by the term "R L M Standard Dome Reflector" and how this name originated.

Chicago, Ill. F. E. G.

The question on page 592 of the December issue of INDUSTRIAL ENGINEER has been called to our attention and in answer thereto, we would submit the following: Several years ago, the illuminating engineer of one of the lamp manufacturers, feeling dissatisfied with the types of industrial reflectors being sold for use with Mazda C lamps, called a conference of all the illuminating engineers of the Mazda lamp manufacturers. As a result of this activity, the design now known as RLM (Reflector and Lamp Manufacturers') Standard Dome Reflector was unanimously agreed upon as the best all-around reflector to make available for the vast majority of industrial lighting problems.

A set of rather rigid specifications was drawn up to insure quality, and the name "RLM Standard Dome" selected as a means of designating the reflectors. In order to assure adherence to the specifications, arrangements were made with the Electrical Testing Laboratories, New York City, to conduct periodic inspection of the product of each manufacturer. Further, to insure a disinterested administration of the plan, the Electrical Testing Laboratories have been requested to handle the relations with the various reflector manufacturers. In accordance with this arrangement, the

**These are the details covered by specifications for porcelain enamel steel reflectors, known as the RLM Standard Dome.**

## REFLECTOR AND LAMP MANUFACTURERS' STANDARD SPECIFICATIONS

### For Porcelain Enameled Steel Reflectors

The Reflector and Lamp Manufacturers' Standard (abbreviated RLM Standard) specifications for dome reflectors, are as follows:

DOME REFLECTORS

*Art. 1. Material and Workmanship*—The material shall be porcelain-enameled steel. The quality and weight of material, and the workmanship, shall be such as to insure a good serviceable product, which will withstand ordinary handling without losing shape and without cracking of enamel

*Art. 2. Angle of Cut-Off*—In every case the reflector shall present a continuous surface so proportioned that in ordinary use with a corresponding MAZDA C lamp of present standard light center length (see table, in Article 3), the filament center will be cut off from view at an angle of 72½ degrees from the vertical axis (17½ degrees below the horizontal). The mean angle of cut-off for a group of reflectors shall not depart from the specifications by more than 1½ degrees, nor individual samples by more than 2½ degrees

Where reflectors having 2¼-inch fitters are supplied without holders they shall be so proportioned that the correct light center position will be obtained when used with the so-called "O" holder, which positions the top edge of the reflector ¾ of an inch below the center contact of the socket.

*Art. 3. Diameter*—For each size of reflector, the effective diameter (i. e., the diameter of the surface well illuminated by the direct rays of the lamp) shall not be less than the values given in the final column of the following table. For convenience, the light center lengths of the MAZDA C lamps and the nominal over-all diameter of reflectors are also included.

| Reflector Designation | MAZDA C Lamp Watts | Light Center Length Inches | Nominal Diameter | Effective Diameter |
|---|---|---|---|---|
| Dome 50 | 50 (White) | 3¾ | 12 | 11¼ |
| " 75 | 75 | 4⅛ | 12 | 11¼ |
| " 100 | 100–150 | 5⅜ | 14 | 13¼ |
| " 200 | 200 | 6 | 16 | 15¼ |
| " 500 | 300–500 | 7 | 18 | 17 |
| " 1000 | 750–1000 | 9½ | 20 | 19 |

*Art. 4. Contour*—The Contour shall be such as to avoid undue concentration of light beneath the unit That is, on photometric test, after the bare lamp candlepower values have been subtracted from the curve of the reflector, the ratio of the maximum candlepower between 0 degrees and 15 degrees and the average of the candlepower values at 25, 35 and 45 degrees must not be greater than 1.35

*Art. 5. Efficiency*—The design of the reflector, reflection factor of porcelain-enamel, etc., shall be such that, with the lamp filament so located as to give an angle of cut-off of 72½ degrees, the output of the complete unit shall be approximately 75 per cent or more of the light generated by the bare lamp The minimum acceptable light output under the specifications shall be 70 per cent.

*Art. 6. Acceptance Criterion*—In judging the acceptability of any group of reflectors under these specifications a reasonable number of samples selected at random shall be examined, and if it is found that an appreciable number fail to comply with the specifications, the inspection shall be continued until a thoroughly representative sampling of the entire lot of reflectors involved has been completed. If more than 5 per cent of the samples so tested fail to comply with the specifications, the group of reflectors shall be considered inferior to these specifications. In view of the variability of the reflection factor of porcelain enamel and other possible deviations, the output of a manufacturer cannot be recognized as complying with these specifications unless checked at least four times a year by a thorough inspection and test of his stock, made as outlined above.

AMENDING SPECIFICATIONS

These specifications may be amended and additional standard specifications adopted from time to time by joint action of the Research Laboratories of General Electric Company and the majority of the number of manufacturers whose product is at that time being regularly inspected, as provided in Article 2, by the Electrical Testing Laboratories

RESEARCH LABORATORIES
GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y

Electrical Testing Laboratories issue inspection-approval labels to such manufacturers as accept the uniform contract (thereby agreeing to maintain the quality) when the product has been found by inspection and test to comply with the specifications.

The wide popularity of the "RLM Standard Dome" reflectors is attributed principally to the following characteristics which are called for in the specifications on page 108.

All of these features were coordinated with a view to securing the highest practicable efficiency compatible with reasonable diffusion and proper distribution, based on rather extended experience in the industrial lighting field.

The aim of the originators was to meet the needs of the general run of industrial lighting problems. It is understood that there are special cases where some other type of equipment might be more desirable. For example, in some processes where minute detail must be carefully observed, it may be desirable to have a higher degree of diffusion than that produced by the RLM Standard Dome reflectors, even when used with the bowl enameled lamp, and it is not presumed to be within the scope of the RLM Standard Dome reflector to cover such cases.

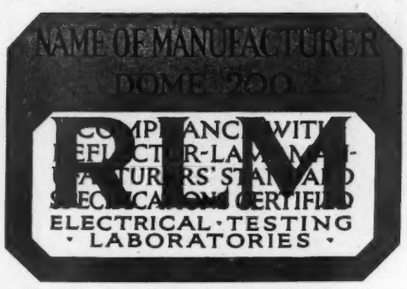
Signed jointly by
G. H. STICKNEY and WARD HARRISON.

Mr. Stickney is illuminating engineer of the Edison Lamp Works of General Electric Company at Harrison, N. J., and Mr. Harrison is illuminating engineer of the National Lamp Works of General Electric Company at Cleveland, Ohio.

* * * *

The registered trade-mark RLM on a reflector means that the reflector bearing this label has been made in accordance with the Reflector and Lamp Manufacturers' specifications. Previous to the adoption of this standard, different manufacturers made reflectors in conformance with each individual engineer's ideas as to what constituted a correct reflector. In fitting lamps to these reflectors, the lamp manufacturers found that these reflectors did not always give the best results, and to solve the problem the engineering departments of the lamp manufacturers called a conference of the various reflector manufacturers for the purpose of designing a reflector which would give maximum lighting efficiency with elimination of glare. The reflectors designed as a result of this conference bear the label "RLM." The association of manufacturers making these at first numbered five members. At present there are at least eight.

These manufacturers then made arrangements with the Electrical Testing Laboratories of New York City for periodic inspections of their products to see that they conform




**Certificate of Inspection Service issued by Electrical Testing Laboratories, New York City.**

to the standards adopted. The inspections are made four or five times a year, and in the event of a certain percentage of the reflectors being found not conforming to the standard specifications, the test certificate or label privilege on that particular type is refused.

The purchaser of a reflector bearing the RLM label is assured of getting a reflector which will give him the maximum amount of reflection when used with the size of lamp for which the reflector was designed.

Supt. Electrical Dept., P. JUSTUS.
Chandler Motor Car Co.,
Cleveland, Ohio.

* * * *

In answer to F. E. G. as to the meaning of R. L. M. Standard Dome Reflectors, I quote the following from the Railway Engineers' Handbook: "After extensive investigation and study, standard specifications covering metal reflectors of the dome type for general illumination have been drawn by the leading manufacturers, and have been issued by the Research Laboratories of the General Electric Company, in which the Mazda service is centered. These specifications, known as the Reflector and Lamp Manufacturers' Standard (RLM Standard) provide: (a) a durable and highly reflecting surface; (b) a contour of reflectors which will insure an effective light distribution; (c) a diameter and depth for each size which will produce adequate diffusion of light and a sufficient screening of the source to minimize glare. Reflectors which comply with these specifications bear a statement in the form of a certificate of inspection service over the signature of the Electrical Testing Laboratories of New York."

Kenova, W. Va. W. A. BIBB.

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**Trouble From Grounded Circuit.**—Recently we were asked to look over a motor circuit for a school which had grounded all of the radiators in the school house. It was a 3-wire, 110-220-volt line entering the building in conduit with a grounded neutral on a pipe. We cut this ground and rung out the circuit and found no other grounds. As the motor does not run mornings we went away only to be called again in the afternoon. This motor is bolted on two pieces of wood in cement and has been running for four years and never given any trouble until this Spring. All the rest of the wiring was O. K. and we let the job go. There has never been anything done as the janitor gave instructions to keep hands off the radiators. What could be the possible cause of this trouble?

Saranac Lake, N. Y. L. J. R.

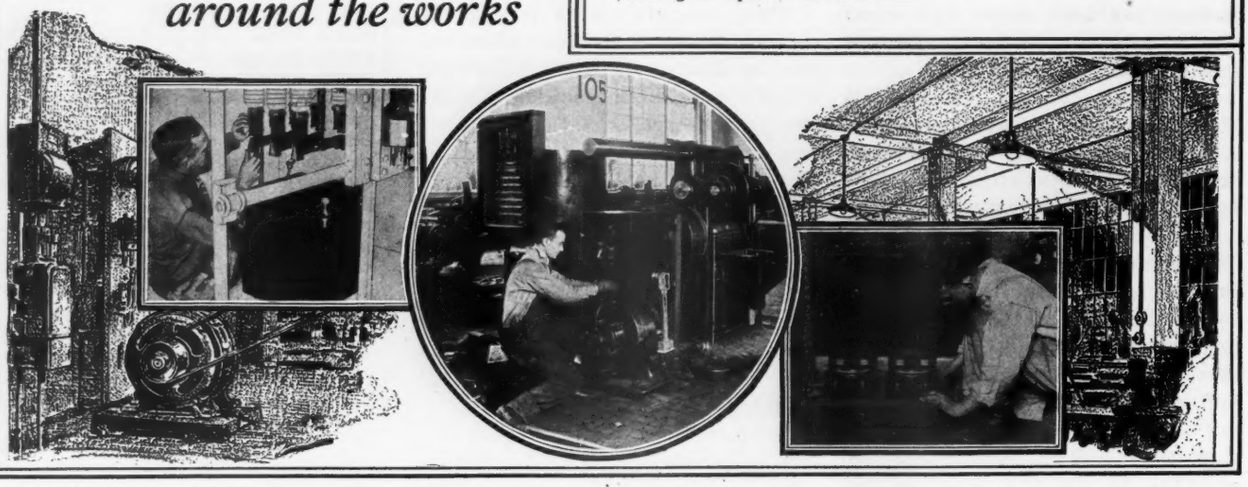
In regard to the trouble from a grounded circuit mentioned by L. J. R. in a recent issue of INDUSTRIAL ENGINEER, I presume the complaint was that a person would receive a shock upon touching a radiator. This would be possible if the radiator system were insulated from the ground, either by design or by a high resistance pipe joint, and then became "grounded to" (in contact with) a live wire. In any case this complaint may be eliminated by grounding the radiator system to a large underground pipe system, to a good ground, or to the neutral of the three-wire system. The ground on the three-wire system should be replaced at once as its absence may cause someone to receive a serious shock. With a grounded neutral the greatest voltage that can be obtained between a live wire and ground is equal to the voltage from the neutral to either outside wire, while with an ungrounded neutral the full voltage between the outside wires may be obtained if an accidental ground is present.

If the trouble occurs only while the motor is running, then look for a grounded motor and insulated radiator system accidentally touching an outside wire. Open the main switch and with the motor off ring out between each outside line and the radiator system. If clear, then ground as stated before. Then with the motor switch open, ring out between each wire on the motor side of switch and the ground. The motor should be cleared of grounds.

Summit, N. J. VICTOR H. TODD.

# SERVICE
## *around the works*

***For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.***



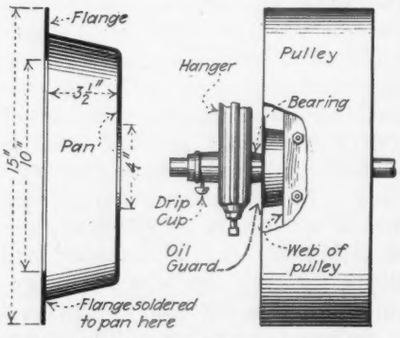
### How to Get Better Service from Flashlight Cells by Cleaning Contacts

I HAVE found that a pocket flashlight battery is indispensable in my work and I carry one with me constantly. I have often noticed, however, that the light would be dim sometimes and bright at others, and putting in new cells frequently did not remedy this condition. Again, the light would go out at times but could be restored by simply jarring the holder which contains two cells arranged, as usual, so that one brass positive carbon tip touches the lamp while the bottom of the cell is in contact with the tip of the next cell, whose bottom is in spring contact with the bottom of the holder. Investigation generally showed all of the contacts to be in apparently good condition. Although the bottoms of the cells were of the color of lead, they would appear to be very clean and anyone would say that the contacts were perfect. I have found that this is not the case, for by simply scraping the cell bottoms so that they showed the bright zinc, all of the troubles from dim lights were completely eliminated. In fact, the lights burned brighter than ever before because there was less voltage drop due to the resistance occasioned by the oxidized condition of the metal. Heretofore, I have thrown batteries away after short use, thinking that they were no good, when I could have obtained considerably more service from them. The moral is, scrape the contact surfaces of the flashlight cells when they are first placed in the holder, and occasionally thereafter. HENRY MULFORD.

Electrician,
Patchogue Electric Light Co.,
Patchogue, N. Y.

### Guard on Pulley Keeps Oil Which Escapes From Bearing From Saturating Belt

TO PREVENT oil from reaching a belt the guard shown in the accompanying drawing is used in a St. Louis shop. Ordinarily a drip cup would be used to catch the waste oil, but in this case there was not room for a drip cup because on account of space limitations, the driven pulley had to be set almost in contact with one of the end shaft hangers, as shown in the drawing. As a result, the oil that oozed out of the bearing dropped on the inside of the pulley rim and flowed to the face of the pulley. In this way the belt became saturated with oil. The oily condition of the belt did not appreciably impair the grip on the wooden driven-pulley, but it did result in continual slipping on the face of the iron driving pulley.




**The sheet-iron guard at the left was fastened to the web of the pulley as shown at the right.**

The difficulty was overcome by attaching a tin oil guard of the form shown in the vertical cross-section. The end hanger was taken down and the guard was slipped over the end of the shaft. It was fastened with wood-screws to the web of the pulley.

Now all of the oil that seeps out of the pulley end of the bearing collects in the oil guard; none of it reaches any part of the pulley. The oil is occasionally removed from the guard by wiping with a piece of cotton waste. A. J. DIXON.

St. Louis, Mo.

### Simple Method of Mounting Starters for Motors of Individually-Driven Machines

OVERHEAD mounting of starters and other equipment often possess many advantages such as are shown by the illustration on the next page which shows two profiling machines direct-connected to two 2-hp., 3-phase, 60-cycle, 440-volt, 1120 r.p.m. induction motors, with the motor control equipment consisting of Iron-Clad safety motor starters mounted on standard channel-iron supports on the ceiling, directly over the machines. The starters are placed so that the operating chains can be conveniently reached by the machine operator.

We use this type of starting equipment on motors up to and including 7½ hp. Where there is no room

available on the machine to mount the standard double-throw switch, these starting switches are mounted on the same channel-iron supports that are used for mounting the standard oil-immersed auto starters and switches which are used on large motors.

F. W. McGRAW.

Swissvale, Pa.

## A Practical Method of Making a Load Test on Direct-Current Motors

HOW to conduct a heating test on a direct-current motor is a question which occasionally confronts the repair man or plant electrician. With it are often associated the problems of correctly setting the brushes and of adjusting the interpoles on a repaired interpole motor. In the case of a motor which has been rewound for a voltage, horsepower, or speed different from what it was originally designed for, these matters are quite vital if the motor is to give satisfaction in future use.

There are several ways of making the heat run or load test as it is called, but the loading-back or pumping-back, two-motor method is probably the most satisfactory. The following procedure has been used often and with uniform success in a certain large manufacturing plant. There are several different hook-ups to be found in various hand-books, but most of them omit important items or leave them to be inferred by the reader, thus causing the inexperienced tester much trouble.

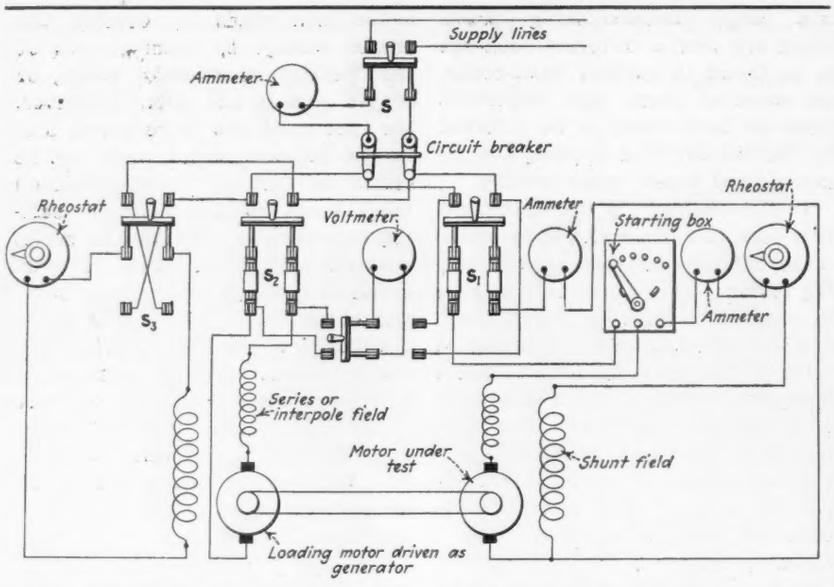
In the diagram on the next page, it is seen that the motor to be tested is mechanically connected to the loading motor. This connection may be by means of pulleys and a belt, chain drive or direct connection through a solid or flexible coupling. If there is available a motor of the same size, speed and voltage as the one to be tested, it should be utilized as the loading motor. However, if such is not the case, a motor should be secured of such rating that when it is being driven by the motor under test it will develop a voltage which will be adjustable, by means of a field rheostat, from a value about equal to that of the supply line to a value about 10 per cent over it, and which will be able to carry the same current as the motor to be tested. For instance, a test was recently made of a 115-volt motor by loading-back with a 230-volt motor. The 115-volt machine was rated, 450-900 r.p.m., 100 amp., and the 230-volt motor had a rating of 650-1000 r.p.m., 100 amp. When connected up for test and driven at 900 r.p.m. (the speed at which the 115-volt motor was to be tested), the 230-volt motor was made to develop the proper voltage by manipulation of the rheostat in its field, which, of course, was on 115 volts. However, the case could not be reversed, that is, the 230-volt motor could not be tested as such by loading-back on the 115-volt machine without inserting considerable resistance in series with the field of the latter. The exercise of common sense in the selection of the loading motor will nearly always result in the securing and proper connection of a motor which will serve the purposes of the test.

The instruments required are an ammeter, and a voltmeter, together with some means of determining the speed of the motors. Two additional ammeters may be used to advantage in the line circuit and the field circuit of the tested motor as shown in the diagram. If only one ammeter is used it must be of sufficient capacity to carry the greatest amount of current to be taken by the motor under test. The other two ammeters, if they are used, may be of a lower range.

When the motor to be tested is properly coupled to a suitable loading motor, connect the various circuits as shown in the diagram. Care must be taken to have the supply line protected by a circuit-breaker or by fuses arranged to interrupt the circuit at about 50 per cent of the maximum current intended to be taken by the motor under test. For example, in testing a motor which will be loaded so as to take 60 amp., set the circuit-breaker to trip or use fuses rated at 30 or 35 amp. The starting-box must be of sufficient capacity to carry the full-load current for the duration of the test and also any overload that it is intended to impose on the motor under test. The fuses on the motor switches, $S_1$ and $S_2$, must be of the same rating as the motor to be tested plus the per cent overload to be given.

It is to be carefully noted that one ammeter must be connected in the circuit on the motor side of the supply line. This location of the ammeter enables it to indicate the full load on the motor and makes it possible to test with only one high-reading ammeter. Were this meter placed on the driven motor side of the supply tap, it would indicate only the current supplied by the generator action of the driven motor. This current is the total current through the driven motor less the current drawn from the supply line.

**Arrangement whereby motor starters are mounted overhead.**




**This is the way to connect the motors for a load test by the pump-back method.**

When the two switches, $S_1$ and $S_2$, and the voltmeter are coupled in as shown, the line voltage and the voltage of the driven motor can be easily compared by throwing the double-pole switch from one side to the other. In case of unexpected trouble, pull switch $S$ or both $S_1$ and $S_2$ or trip the circuit breaker.

By coupling the two switches, $S_1$ and $S_2$, and the voltmeter as shown, the line voltage and the voltage of the driven motor can be easily compared by throwing the double-pole switch from one side to the other.

The test is conducted by closing the switch $S_1$ and manipulating the starting-box to start the driving motor. Adjust the speed of the latter by means of its field rheostat. This rheostat may be a few standard resistance tubes in parallel, shunted by a small knife switch which is to be closed during starting. Adjust the brushes of the tested motor and see that everything is running smoothly. The brushes on the driven motor should be set at approximately correct position unless they have already been so located.

Next close $S_3$, which will energize the field of the driven motor. Try the polarity of the voltage generated by throwing the double-pole voltmeter switch to the $S_2$ side; check with the line voltage, and if the polarities are not the same, reverse $S_3$. Then build up the voltage generated by the driven motor until it checks to within 2 or 3 volts of the line voltage. Now, and not until now, close $S_2$. The inexperienced tester must be warned against closing $S_2$ at any other time than when the above conditions exist. A short-circuit through the armature of the driven machine is apt to result if this switch is closed otherwise. Also, the switch $S_3$ must never be opened before opening $S_2$. Short-circuit phenomena are again invited by this action due to throwing the armature of the driven motor across the line without a field.

When $S_2$ is closed as directed, the ammeter will show hardly any change in reading and both motors should continue to run smoothly and at unchanged speed. Then commence to cut out the field resistance of the generating motor. Do this very slowly, giving time for conditions to settle after each increase in load current as indicated by the meter. In this matter it is to be noted that when testing motors which have a wide range of speed obtainable by field weakening (commutating or interpole motors) it is necessary to have a very finely divided field rheostat in the field circuit of the loading motor. Unless the rheostat is of the type mentioned when motors such as are referred to are being tested the large changes in field strength will produce such great changes in voltage as to cause violently rapid loading of the tested motor with possibly dangerous overloads or a short circuit between the two armatures.

After the required load current has been reached, speed readings should be taken and commutation observed and carefully recorded, together with the time at which the motor reached full load. As the rheostats heat up and their resistances increase accordingly, the load will decrease slightly; this can be compensated for by a readjustment. The load will remain quite steady however, regardless of slight fluctuations in the supply voltage. It will be noted during the progress of the test that the tested motor is considerably warmer than the generating motor. This difference in temperature may be a matter of much concern at first glance if the two motors are identical, but it is natural and not necessarily indicative of trouble.

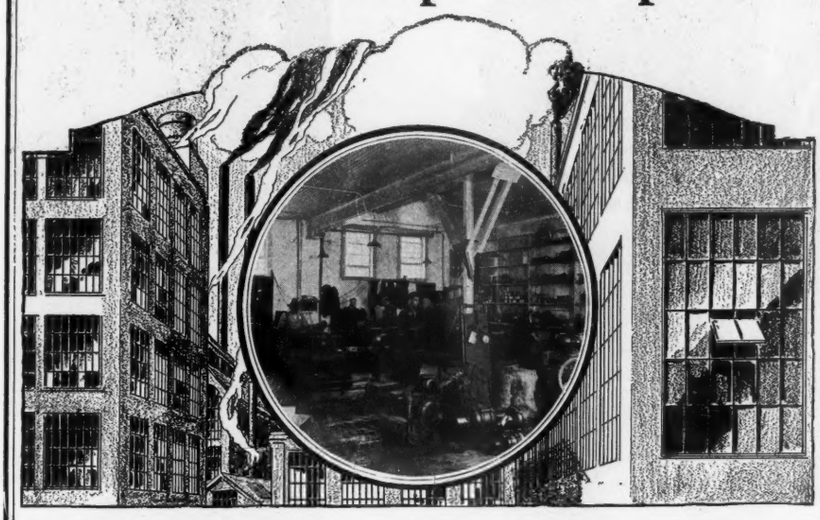
Upon completion of the load test or heat run, the load may be removed in small steps and speed, voltage and current, readings taken at each step. This will take but a few minutes and will give the data for the valuable speed-load or regulation curve of the motor. Do not decrease the load current too quickly, nor to a smaller value than it had at the beginning of the loading operation. It is better, in fact, to unload to not less than 10 per cent of the full-load current, then open $S_2$ and finally, to stop the motors, open $S_1$. If the supply switch $S$ is near at hand the two motors may be stopped by opening it when the load is down to this value. Temperature readings on the various parts may now be made if information is desired on the final rise in temperature.

Keep a cool head and in case of unexpected trouble necessitating stopping the motors, pull the switch $S$, or trip the circuit-breaker if either are near at hand. If they are not, pull both switches $S_1$ and $S_2$. Both must be pulled to stop the testing set, as if $S_1$ only is pulled, the generating motor will continue to run as a plain motor.

If it is desired to determine the efficiency of the motor under test the resistances of the field and of the armature circuits should be measured immediately after getting the temperature readings. These in connection with the values of field and motor amperes observed during the test will give data for the calculation of the copper losses. The stray-power losses may be determined closely enough by disconnecting the two motors and running the motor under test idle at the same speed it had during the test, noting the voltage and the amperes input. The product of these two quantities less the copper losses as calculated for the running-idle amperes will be the stray-power loss. The calculation of the efficiency is then a simple matter.

Gurney Elevator Co., Honesdale, Pa. J. M. WALSH.

# In the Repair Shop



*This section is devoted to all sorts of electrical repair work, large and small. Special attention is given to tools found convenient at the shop bench and short cuts or improved methods. Articles on these subjects are always welocme.*

## Improvised Press Used to Force New Lining in Pump Cylinder

RECENTLY we had occasion to reline a boiler feed-water pump which suddenly developed trouble. The piston, piston rod, stuffing box and gland were first removed. A wedge was then driven between the old lining and the cylinder wall for the entire length of the lining. Into the gap thus formed a crowbar was inserted and forced down until the lining buckled in the middle. The lining was then easily drawn from the cylinder.

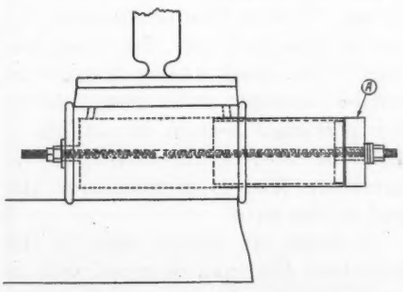
A collar *A* was then turned out on the lathe, the outside diameter being made just an easy fit for the inside of the cylinder. A flange was next turned in the collar so that this smaller diameter fitted snugly inside the new lining. Through the center of the collar a 1¼-in. hole was drilled.

A long rod of good quality steel, 1 in. in diameter, was then threaded throughout its entire length and passed through the cylinder. This rod had on the farther end a ½-in. iron plate which also had a 1¼-in. hole drilled through it. Holding the plate in place were two heavy nuts.

The new lining was then slipped over the projecting rod and tapped lightly until it had a slight start in the cylinder. The collar was then fitted in place as shown and several heavy washers placed on the rod, the whole being finished by screwing on an extra heavy nut.

The entire surface of the new lining was then generously smeared with white lead and the nut forced on with a large wrench. When this is done care must be taken in passing over the head-end port to see that the edge of the lining does not catch on the farther edge of the port opening. The nut must not be screwed up too quickly at first, as excessive pressure might buckle the lining. Plenty of oil should be kept on the nut and washers to reduce friction as much as possible, and the the sleeve should be continually tapped with a mallet. When the lining is almost in place it should be watched closely so that it will not be forced in too far, and so obstruct farther port opening. If the collar passes into the cylinder so far as to make it difficult to ply the wrench, remove the nut and build up with washers. If the rod shows a tendency to turn with the nut, apply a Stillson wrench at the farther end.

After the lining has been adjusted to its proper place, the pump should be assembled again and new packing placed in the stuffing box and around the piston. JAMES P. MARSHALL.
Boston, Mass.

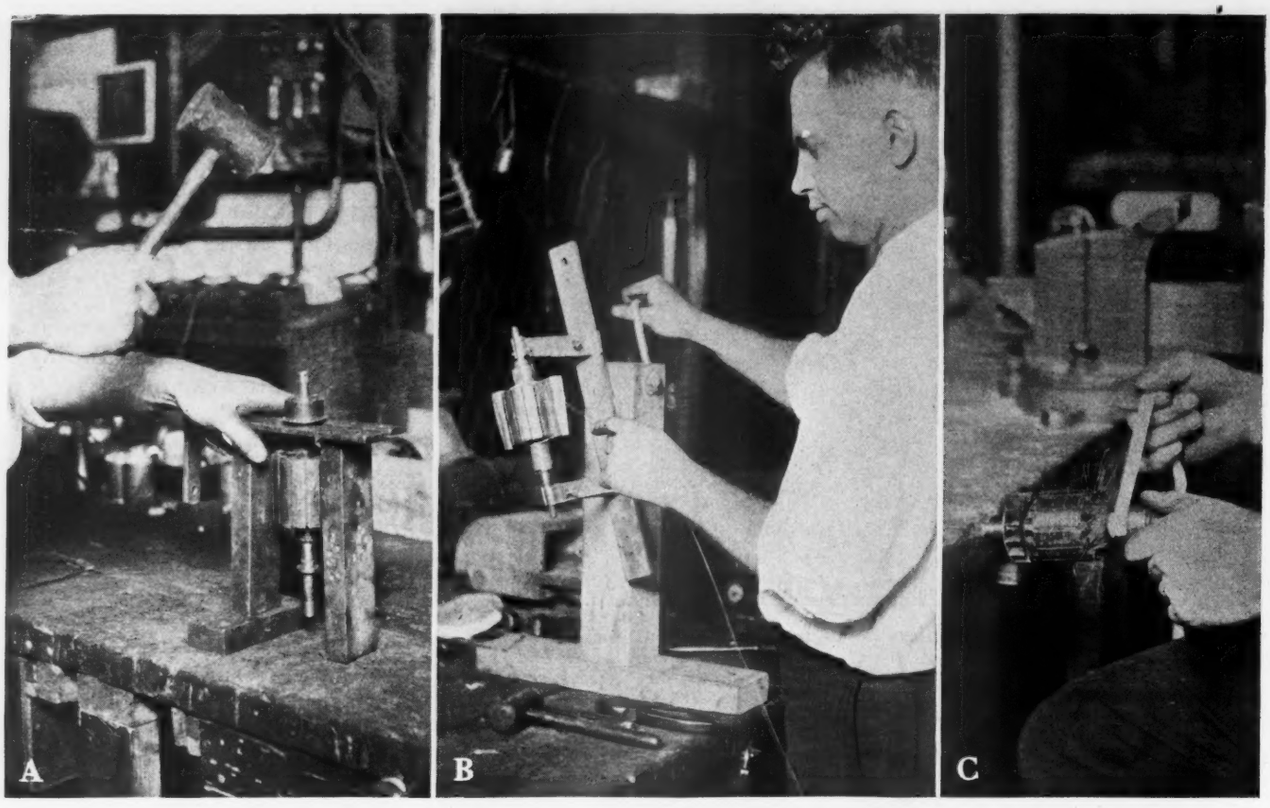



**Precautions to take when forcing a new lining into a pump cylinder are explained in the accompanying item.**

## Simple Devices Which Are Useful in Winding Small Armatures

THERE are several simple and easily made devices which I have found can be used to advantage in rewinding hand-wound armatures of small motors. An armature to be rewound is first stripped, the number of coils per slot and the number of turns per coil counted, and note taken of the throw of the armature leads for the commutator connection. After all the wire has been removed and the insulation gaged, the distance between the commutator and the end of the shaft is measured, and the commutator removed from the shaft. This can be done in the manner shown in an accompanying illustration by suspending the armature on two flat pieces of steel which are placed under the commutator and supported on wooden uprights. By pounding on the end of the shaft with a rawhide or lead hammer, the commutator can be easily forced off. If desired, a clamp with a setscrew can be used for this purpose; the clamp should fit behind the commutator and by turning the setscrew a sufficient pressure can be exerted on the end of the shaft to pull the commutator off.

When the armature is ready for rewinding, the shaft and core ends are re-insulated with empire cloth, which is cut circular with an opening for the shaft and then slipped on like a washer, and shellacked to the core end. The shaft is insulated by wrapping it with tape outward from the end of the core. This insulation is extended along the armature shaft farther than is necessary and then is cut close to the winding when the job is completed. For slot insulation I use 10-mil leatheroid on 110-volt motors and on 220-volt motors 10-mil leatheroid with one sheet of empire cloth. The slot insulation is cut ¼ in. longer than the length of the slot, thus allowing the insulation to over-




**Three steps in rewinding armatures of fractional horsepower motors.**

*A*—Removing commutator by pounding with rawhide hammer on end of shaft, while the armature is suspended on two flat iron bars supported on wooden uprights. *B*—The base of this winding device is a piece of 2-in. by 4-in. wood, while the upright is a piece of 4-in. by 4-in. The shaft and crank of the rotating part are made of iron. The bar which supports the armature is a piece of ½-in. by 2-in. iron, about 18 in. long. The holding clamps are of light strap iron, 4 in. to 6 in. long. *C*—Cotton tape is wound around the armature shaft to fill the space between the commutator and winding and give a firm support for the fine commutator leads. After the leads have been soldered in place they are bound down with string.

lap the core and protect the winding from the corners of the slot. When winding, care must be taken not to cut this insulation with the wire. The insulation for the slot should extend ½ in. over each edge of the slot, in order to allow the wire to be guided into place with ease.

For winding the armature the simple winding machine shown in the accompanying illustrations will be found convenient. As will be noted, the upright and base can be made of 2-in. by 4-in. lumber, or of pipe and pipe fittings if desired. The flat piece of steel supporting the armature is ¼ in. thick, 2 in. wide and about 18 in. long. It is firmly attached in the center to a short piece of pipe, or bar, which passes through the bearing in the upright and on the other end is fitted with a crank for turning the armature. Two clamps are used to support the armature. These clamps are 4 in. or more long, depending on the size of the armature core.

The winding machine is placed on one end of the bench and a stand for holding the reel of wire is placed on the floor. Of course, the same size of wire and the same kind of insulation should be used for rewinding the armature as were formerly employed, unless there is some good reason for a change. A micrometer or a wire gage may be used to determine the size of wire previously used in the armature, and the type of insulation may be determined by inspection and measured for thickness.

After the proper wire is selected and put on the reel stand, the end of the wire is loosened from the reel and a foot or so is cut off with a pair of pliers. This is done to eliminate the use of stretched wire, for when fine wire is put under tension it stretches until it becomes under-sized. After the stretched section is cut off, a piece of sleeving the length of the armature lead is slipped over the end of the wire.

If there are twelve slots in the armature the span of a coil will be from 1 to 6. Starting at the commutator end of the armature, the first armature lead is fastened to one of the clamps of the winding machine or secured in a slot of the armature.

The armature is then turned by means of the handle of the winding machine and the wire guided into the slot until the required number of turns have been applied to complete one coil. The end of the coil is carried to the next slot, but before again starting to wind, a few inches of wire are allowed for the armature lead and twisted into a loop. Then the next coil is started, and so on until all of the coils have been wound.

The last coil ends where the first coil began. The sleeving of the armature leads can be done either while winding or after the winding is complete. A thin strip of fiber can be used to force the wire into the slots in case there is a very close fit at the core edges.

When two coils are placed in one slot the armature leads can be marked for commutator connection by making an extra number of twists in the end of the loop. After completing the winding, the insulation is trimmed and either fiber wedges are put in the slots to hold the wire in place, or band rings are wound around the armature core. The open ends of the windings are then connected to a test set to detect

grounds. If a ground is present it will probably be found at the slot end. Such grounds may be cleared by pushing the wires back and inserting between the wire and the core end a small piece of insulation covered with shellac. The commutator is next pressed onto the shaft and the armature lead brace put between the armature winding and the commutator. As shown in one of the illustrations, this is done by winding cotton tape around the armature shaft to a sufficient depth to fill the space between the commutator and the winding. This gives a firm support to the fine wires and prevents them breaking off.

The armature leads are then brought down to the commutator and soldered in place, care being taken to see that the leads have the same throw as in the old winding. After the wires are soldered in place they must be bound down against the tape supports with a string band.

For testing the armature for open circuits and shorts, a telephone receiver is employed, the ends of the receiver cord being placed across two bars. Current is supplied through a lamp bank to two nails which are driven in the bench and touch each side of the commutator. The ends of the telephone receiver cords are moved over two segments at a time, and from the character of the sound in the receiver the nature and location of trouble in the armature may be detected. Open circuits produce a very loud noise, while with short circuits no sound can be heard. When all of the bars give a uniform sound, the armature can be considered to be all right.

After the rewound armature has been tested and any defect found present removed, it is then shellacked and baked for three hours, or if preferred, an air drying insulating paint may be used. If necessary, the commutator may then be turned down or smoothed and the armature is ready for use.

For coil-wound armatures the coils can be made on the winding machine by placing two screws in the steel plates and putting insulation over them so that covering of the wire will not be injured. After winding, the loops are bent into the proper shape and placed in the armature.

Chicago, Ill. H. E. EWALT.

## Size of Wire for Alternating Current Motor Leads and Jumpers

WHEN repairing a motor new leads and jumpers are often put on. The sizes of rubber-covered wire to use for this purpose are given in the accompanying table and apply to motors of 100 to 600 volts, one, two or three phases, and twenty-five or sixty cycles.

The table gives the sizes for a series connection of the winding. With a winding connected in parallel the leads would be the same but the jumpers would be smaller. For a two-parallel winding the rated amperes should be divided by two and the jumpers taken which correspond to this current. Likewise for a three-parallel winding, the amperes should be divided by three and so on.

### Size of Rubber-Covered Wire for Jumpers and Leads of A.-C. Motors

These sizes apply to motors of 100 to 600 volts, 25 to 60 cycles, and one, two or three phases.

| Rating of Motor, Amp. | *Jumpers, B & S Gage No. | Leads (Flexible Cable) | |
|---|---|---|---|
| | | No. of Conductors | B & S Gage No. |
| 1 to 6 | 16 | 19 | 27 |
| 7 " 15 | 14 | 19 | 27 |
| 16 " 20 | 12 | 19 | 25 |
| 21 " 25 | 10 | 19 | 23 |
| 26 " 35 | 8 | 19 | 21 |
| 36 " 50 | 6 | 49 | 23 |
| 51 " 70 | 4 | 49 | 22 |
| 71 " 80 | 3 | 61 | 21 |
| 81 " 90 | 2 | 7 | 11 |
| 91 " 100 | 1 | 19 | 14 |
| 101 " 125 | 0 | 19 | 13 |
| 126 " 150 | 00 | 19 | 12 |
| 151 " 175 | 000 | 19 | 11 |
| 176 " 225 | 0000 | 19 | 10 |

*The values given are for series-connected windings. For two-parallel windings, divide rated amperes by two and use jumper corresponding to this current. For three-parallel, divide by three; for four-parallel, divide by four, and so on.

For example, if the winding of a motor rated at 50 amp. per terminal is series-connected the jumpers will be No. 6 and the leads a flexible cable of forty-nine No. 23 conductors. If the motor rated at 50 amp. has a two-parallel connection, the leads will still be a cable of forty-nine No. 23 wires. To find the size of the jumpers, however, divide the amperes by two (50÷2=25) and look for the jumpers required for this current, 25 amp. In this case the jumpers would be No. 10.

For a 63-amp. motor with three-parallel winding, the leads will be cables of forty-nine No. 22 wires. The jumpers (for 63÷3=21 amp.) will be No. 10.

In the last case a No. 12 jumper could be used instead of a No. 10 without danger. In fact a margin of 3 amp. is allowed. For instance for 83 amp. a No. 3 jumper could be used without any bad effects.

Detroit, Mich. A. C. ROE.

## Hand-Whittled Wooden Screwdriver Facilitates Assembly of Small Parts

FREQUENTLY it is necessary to assemble devices under very difficult and trying conditions, for instance, holding parts and at the same time inserting screws in holes which are hard to reach. When I have a job like this I make a wooden screwdriver of either hard or soft wood, and of a size to suit the conditions, and cut the point so as to make a press fit in the screw slot.

Such a driver will hold the screw nicely and will usually have strength enough to start the screw, after which it can be sent home with a metal driver. I have used this scheme for several years and find that it saves much time and effort as well as patience.

I have made drivers from an ordinary match for use on small work and from scrap pieces of wood which can always be found around the plant, for other work, and find that they beat anything I have ever tried in the way of spring point screwdrivers, using soap on an ordinary driver and various other familiar devices for doing miscellaneous jobs of this sort. In case of an emergency they can be made on the job in a few moments. HENRY MULFORD.

Electrician.
Patchogue Electric Light Co.
Patchogue, N. Y.

*Better ways to transport and handle raw and finished parts in and around the works will be discussed in this section.*

## Handling 40 Tons of Loose Screw Machine Turnings Daily From the Shop to Pit Storage by Tractor and Trailers

ONE OF the subjects that was given a great deal of attention by the National Acme Company, Cleveland, Ohio, when it erected its new screw-machine products plant, was the handling of scrap. The method finally adopted for taking care of this material has proved both convenient and economical, and is a decided improvement over the method formerly used of handling scrap in wheelbarrows.

The company produces in its plant over 40 tons of scrap per day. The scrap is all turnings, which are bulky in form. The day's output in screw-machine products and turnings is scraped out from beneath the machines at night in order that a full day's work can be done on the automatics during the daytime. The material is placed in steel buckets about 8 in. in diameter and 14 in. deep. In the morning the buckets are dumped into oil separators, and after the oil is extracted the product and scrap go to the chip separators. From these the product passes on through washing machines to the inspection department. Every machine is numbered and a large sheet-iron tag bearing this number travels with the work until the product is weighed and recorded. Then the tag is sent back to the machine from which it came. This prevents similar parts from getting mixed and makes it easy to identify them.

The turnings are shoveled from beneath the chip separators into dump-hopper trucks. Six of these trucks are used and one Elwell-Parker Electric and Manufacturing Company's (Cleveland, Ohio) storage battery tractor is provided for hauling the trucks. Usually the tractor hauls two loaded trucks on a trip. The capacity of each truck hopper is 40 cu. ft., or approximately a ton of turnings.

The scrap is hauled outside the building and dumped into a concrete pit 200 ft. long, 25 ft. wide and approximately 12 ft. deep, which has a capacity of about 30 carloads of turnings. This pit is built in the platform alongside of two railroad tracks at the side of the plant. These tracks also serve the raw-material receiving department. Sufficient space is provided for running the trucks on either side of the pit. From the pit the scrap is loaded on cars by a locomotive crane equipped with a grab bucket. It takes only about 30 min. to load a standard railroad car. The crane is electrically operated, the electrical connection being made through plugs located near the track in the platform. A railroad scale is located in one of the sidings for weighing the empty cars and loads of material.

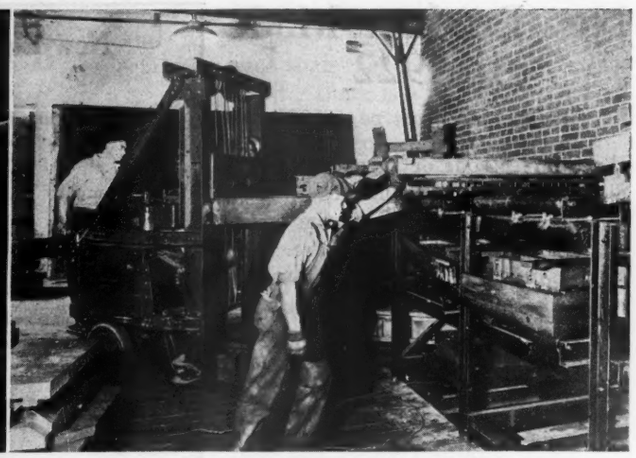
**This electric storage battery tractor hauls two trailers loaded with turnings, from the plant to the storage pit where they are dumped.**

The truck hoppers each have a capacity of approximately one ton and dump their loads into a concrete pit of 30 carloads capacity. An electrically operated locomotive crane can load a standard railroad car in about 30 min. with a grab bucket. Because these turnings tangle so badly, it would be difficult for a gang of men to take them out of the pit.

## Reducing a Job From Several Hours to a Few Minutes

AMONG the jobs around a shop, which men who have introduced efficient material-handling equipment have found that they can make a big reduction in costs, is the handling of dies to and from presses and storage. With ordinary methods of doing this work, this job would require a gang of four or five men several hours. This would mean, in addition to the labor involved, a loss of production of the press which, according to its size, might vary

**Doing a 3-hour job in a few minutes.**
Instead of spending several hours in changing dies and thus holding up production on the press, two men can change a die in just a few minutes. The truck not only removes the old die but also brings the new one from storage.



**Putting the die in storage.**
Roller conveyor sections in these die storage racks make it easier for the operator to insert or remove dies. Racks three high as in this case also economize in storage space. In addition, dies carefully stored in racks are less likely to be damaged than if piled in a haphazard manner and are more easily kept track of.

from $5 to $25 or more an hour.

At the Detroit plant of the Fisher Body Company, idle time of the presses due to changing of dies has been reduced to a minimum by the use of a Baker R. & L. "Hy-Lift" or tiering truck shown in the two accompanying illustrations. The illustration at the left shows the truck approaching the press ready to pick up on its platform the die which is here loosened and resting on the bed of the press. The platform of this truck can be raised or lowered until it is the exact height of the punch press so that the die can be easily pushed across from one to the other. This requires only a few minutes in contrast to other methods which require special rigging to elevate the die into position and set it on or off the press bed.

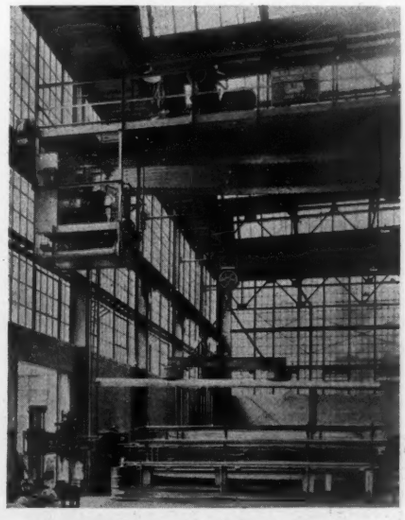
The illustration at the right shows how easily the die may be stored. Here the storage racks are provided with roller sections so that dies may be more easily slid on or off. The platform of the truck may be raised or lowered so as to pick up dies from any of the three tiers in the rack. In the same way they may be as easily replaced in any section.

This has reduced the time off for changing dies from several hours to a few minutes with a consequent saving not only in the labor involved but also, and more important, a reduction of the non-productive period of the press. At other times when not changing dies this truck may be used for handling skid platforms the same as any other lift trucks, or for piling loaded platforms one on the other and so doubling the capacity of the storage space.

This truck has a lifting capacity of 4,000 lb. with a vertical travel of from 11 in. to 72 in. Separate motors are provided for travel and lifting. The platform is raised and lowered through a special two-cable hoist. The Baker R. & L. Company, Cleveland, Ohio, made the installation.

## Storage Capacity Doubled by Using Crane and Magnets to Pile Higher

ONE OF the shortcomings of hand-piling is that frequently it requires almost as much space for the men doing the piling as it does for the storage of the material. As this space is also required for unpiling it is in reality just that much of a waste. Also, hand piling seldom, if ever, can be carried as high as mechanical piling. The advantages of mechanical piling are well exemplified in the Chicago warehouse of Kelly and Jones Company. Here a Pawling and Harnischfeger (Milwaukee, Wis.) 10-ton overhead traveling crane is equipped with two 20-in. Ohio Electric and Controller Company (Cleveland, Ohio) round magnets mounted on a spreader beam. Pipe up to 20 ft. in length is handled by this crane and magnet from the car to the pile and also from the pile to the motor truck for city delivery. The two magnets will handle about 1,500 lb. of pipe in lengths up to 20 ft. at a lift.



**By piling and unpiling pipe stock with a magnet, aisle space is saved.**
In addition, it is possible to pile about twice as high and so more than double the capacity of the warehouse. Two magnets on a spreader bar, as here, make it possible to pick up long pieces with less danger of an accident.

Stakes are set in "shoes" which are placed in the concrete floor. The spacing and height of these stakes determine the size of the pile. As the pipe is lifted in and out at the top of this pile it is not necessary to leave wide aisles as would be essential if it were piled by hand or if it were necessary for the men to get to and from the piles for engaging or disengaging chain slings. The pipe is piled 18 to 20 ft. high, which is about twice as high as would have been possible if it were piled by hand or if chains were used. This additional height and the practical elimination of the aisle has enabled the pipe to be stored in less than half the warehouse space which would otherwise be necessary. One man from the floor directs the operation of the craneman in piling or selecting stock for delivery.

# New Products Made in 1922

(*Continued from page* 103)

the top electrode or through the top electrodes and the furnace hearth. A balanced load results on the transformer primaries in each case.

An induction type of furnace adapted to melting non-ferrous metals has been developed by the General Electric Company. The melting chamber of this furnace in which the charge is received, melted and held for pouring, resembles an ordinary crucible with an enclosed top and with a charging door on one side and pouring valve on the other. Communicating with this chamber through ports is another chamber in the form of a hollow cylinder which encircles a primary winding and one leg of a laminated iron core. Molten metal in this cylindrical chamber constitutes the secondary of a transformer and the heat is generated by the secondary current which flows around the cylinder. The refractory lining is constructed of three parts which are formed and fired before placing inside the furnace. For yellow brass the furnace holds 1,200 lb., with a capacity of 750 lb. Running continuously, the power consumption is 200 kw.-hr. per ton of brass. On 60 cycles the power factor is about 75 per cent.

Three electrically heated furnaces for vitreous enameling have been installed on the Pacific Coast by the Electric Furnace Construction Company, Philadelphia, Pa. Each of these is rated at 210 kw. An electric oven with a wide field of usefulness has been developed by the Despatch Manufacturing Company, Minneapolis, Minn. The oven has a temperature range of 100 to 400 deg. F. and a power consumption of 200 to 900 watts. The oven is controlled by a three-heat switch. It measures 18 in. wide by 14 in. by 14 in. A complete line of small and medium-sized industrial ovens has been put on the market by the Westinghouse Electric & Manufacturing Company. All of these ovens have temperature ranges of 100 deg. F. to 600 deg. F. A line of cartridge-type heaters ranging from ½ in. in diameter and 2¼ in. long to 1 15/16 in. diameter and 8½ in. long with capacities of 100 to 1,000 watts is offered by the same company. A

## New Equipment Developed in 1922 for Use in Industrial Works

*The number in the right-hand column refers to the page of this article where details are given. The (*) indicates that details have been given in advertisements during 1922 in Industrial Engineer*

| Equipment | Type or Use | Manufacturer | See Page |
|---|---|---|---|
| Attachment Plug | Armored | Arrow Electric Co. | 95 |
| Ball Bearing | Two ball grooves | Standard Steel Bearings Co. | 102 |
| Battery Station | Charging outfit | Hobart Brothers | 97 |
| Battery Station | Cell filler | Electric Storage Battery Co. | 101 |
| Battery Station | Water still | Barnstead Still & Sterilizer Co. | 101 |
| Battery Station | Discharge rate tester | Service Station Supply Co. | 101 |
| Battery Station | Electrically heated knife | Service Station Supply Co. | 101 |
| Bearing Metal | Copper-lead | Stewart Mfg. Co. | * |
| Blow Torch | Shop | St. Paul Welding & Mfg. Co. | * |
| Brush Connection | For commutator brushes | Boxill-Bruel Carbon Brush Co. | 96 |
| Bunsen Burner | Improved | Henry Heil Chemical Co. | * |
| Bushings | Reducer for knockouts | Adapti Co. | 94 |
| Cable | Fittings for | National Metal Molding Co. | 94 |
| Control | Paper-machine drive | General Electric Co. | 90 |
| Control | Printing press | General Electric Co. | 91 |
| Control | Mill drives | Westinghouse Electric & Mfg. Co. | 90 |
| Circuit Breaker | Enclosed | Roller Smith Co. | 94 |
| Circuit Breaker | Enclosed | Cutter Company | 94 |
| Circuit Breaker | Enclosed for motor starting | Monitor Controller Co. | 93 |
| Cord | Dreadnaught portable | Indiana Rubber & Insulated Wire Co. | * |
| Electric Drill | Portable | Jones, MacNeal & Camp | 93 |
| Electric Furnace | Induction | General Electric Co. | 118 |
| Electric Furnace | For vitreous enameling | Electric Furnace Construction Co. | 119 |
| Electric Furnace | Steel making | Electric Furnace Construction Co. | 118 |
| Electric Oven | Wide temperature range | Despatch Mfg. Co. | 119 |
| Electric Oven | Small size | Westinghouse Electric & Mfg. Co. | 119 |
| Electric Welder | High current value | Westinghouse Electric & Mfg. Co. | 119 |
| Electric Welder | Portable | General Electric Co. | 119 |
| Field Coils | Aluminum | Economy Electric Devices Co. | * |
| Fitting | For conduit | Killark Electric Co. | 94 |
| Fuses | Indicating plug | A. L. Lewis Co. | 94 |
| Fuses | Cartridge renewable | Westinghouse Electric & Mfg. Co. | 94 |
| Fuses | Knife-blade renewable | Bussman Mfg. Co. | * |
| Fuses | Cartridge and plug | Southern Electric Co. | 94 |
| Fuses | Non-indicating | Johns-Pratt Co. | * |
| Fuses | Fiber plug | Trico Mfg. Co. | 94 |
| Fuses | Plug | General Electric Co. | 94 |
| Fuses | Fuse reducer | Plainville Electrical Products Co. | 94 |
| Fuses | Cutout base for | Bryant Electric Co. | 94 |
| Fuses | Puller and replacer | Fuse Puller Co. | 94 |
| Instruments | Insulation resistance tester | Westinghouse Electric & Mfg. Co. | 102 |
| Instruments | D.C. and A.C. | Westinghouse Electric & Mfg. Co. | 102 |
| Instruments | Foot-candle meter | Keuffel & Esser Co. | 101 |
| Insulators | Low voltage | R. Thomas & Sons Co. | 94 |
| Key | For pulleys | Smith & Serrell | 103 |
| Lamps | Mill type | Westinghouse company and Edison and National Lamp Works of G. E. Co. | 102 |
| Lamp Guard | Portable | Wm. N. Matthews & Bro. | 101 |
| Lightning Arresters | For industrial works | Westinghouse Electric & Mfg. Co. | 102 |
| Lightning Arresters | For industrial works | General Electric Co. | 102 |
| Motors | Synchronous | General Electric Co. | 89 |
| Motors | Induction | Louis Allis Co. | 89 |
| Motors | Induction | Electric Controller & Mfg. Co. | 90 |
| Motors | Induction | Wagner Electric & Mfg. Co. | 90 |
| Motors | Enclosed | American Electric Motors, Inc. | 90 |
| Motors | A.C. self-starting | Fidelity Electric Co. | 90 |
| Motors | Interchangeable frames | Master Electric Co. | 90 |
| Motors | Split-phase | Reynolds Electric Co. | 90 |
| Motors | Repulsion-start | Dayton Fan & Motor Co. | 90 |
| Motors | Fractional synchronous | France Mfg. Co. | 90 |
| Motor Starters | Across-the-line | Allen Bradley Co. | 92 |
| Motor Starters | Across-the-line | Industrial Controller Co. | 92 |
| Motor Starters | Resistance | Sundh Electric Co. | 92 |
| Motor Starters | Automatic | Sundh Electric Co. | 92 |
| Motor Starters | Safety | Union Electric Mfg. Co. | 93 |
| Motor Starters | Automatic | Cutler-Hammer Mfg. Co. | 93 |
| Pulleys | Paper composition | Composition Wood Products Co. | * |
| Repair Shop | Winding devices | P. E. Chapman Electrical Works | 95 |
| Repair Shop | Commutator turner | George Bender | 96 |
| Repair Shop | Armature winder | T. F. Rhoades | 96 |
| Repair Shop | Commutator grinder | Martindale Electric Co. | 96 |
| Repair Shop | Test bench | Paul G. Niehoff & Co. | 97 |
| Repair Shop | Solder pot | Westinghouse Electric & Mfg. Co. | 97 |
| Repair Shop | Heating furnace | Opal Electric & Mfg. Co. | 97 |
| Repair Shop | Heating furnace | Instantaneous Heater Co. | 97 |
| Repair Shop | Soldering iron | Rohne Electric Co. | 97 |
| Repair Shop | Blow torch | Armature Coil Equipment Co. | 97 |
| Repair Shop | Tool for turning, etc. | Triplex Machine Tool Corp. | 97 |
| Repair Shop | Fish wire | T. J. Cope | 97 |
| Repair Shop | Adjustable cutter | Paul. W. Koch & Co. | 96 |
| Repair Shop | Pipe wrench | Greenfield Tap & Die Corp. | 97 |
| Rotary Converter | Martin | Northwestern Electric Co. | * |
| Signal Service | Watchman and fire alarm | Edwards & Co. | 101 |
| Signal Service | Bell-ringing transformer | Dongan Electric Co. | 101 |
| Switches | D.C. automatic reclosing | General Electric Co. | 93 |
| Switches | Mercury contact | Federal Gauge Co. | 94 |
| Switches | Remote thermostat | Minneapolis Heat Regulator Co. | 94 |
| Switches | Time signal | Stromberg Electric Co. | 94 |
| Switches | Safety across-the-line | Z & H Mfg. Co. | 94 |
| Switches | Safety across-the-line | Trumbull Electric & Mfg. Co. | 93 |
| Switches | Safety motor starting | Mutual Electric & Machine Co. | 93 |
| Switch | Shallow push button | Arrow Electric Co. | 94 |
| Switchbox | Shallow sectional | Chicago Fuse Mfg. Co. | 94 |
| Snap Switch | Cleat base indicating | Bryant Electric Co. | 95 |
| Steam Generator | Electrically heated | Electric Furnace Construction Co. | 118 |
| Steam Generator | Electrically heated | General Electric Co. | 118 |
| Tape | Seamless bias | Irvington Varnish & Insulator Co. | 96 |

small furnace 1 in. in diameter and 3½ in. deep, which will maintain a temperature of 1,500 deg. F., has been completed by the same company for heating small soldering irons and for special work.

In arc welding the demand for increased production and more rapid deposition of metal has caused the use of larger electrodes and higher current values. Values of 300 amp. and over are now used. A new constant-current welder has been built by the Westinghouse Electric & Manufacturing Company for this heavy work. A portable welding outfit driven by a gas engine has been developed by the same company. The General Electric Company has adapted the design of its automatic welding outfit to a portable semi-automatic welder.

# Fuse Protection For Motors

(*Continued from page* 88)

operating temperature of these fuses referred to here. Tests were made on several fuses as shown in Table III. It was found that the temperature of the new fuses at rated current is about 20 deg. C. lower than that of the original fuses.

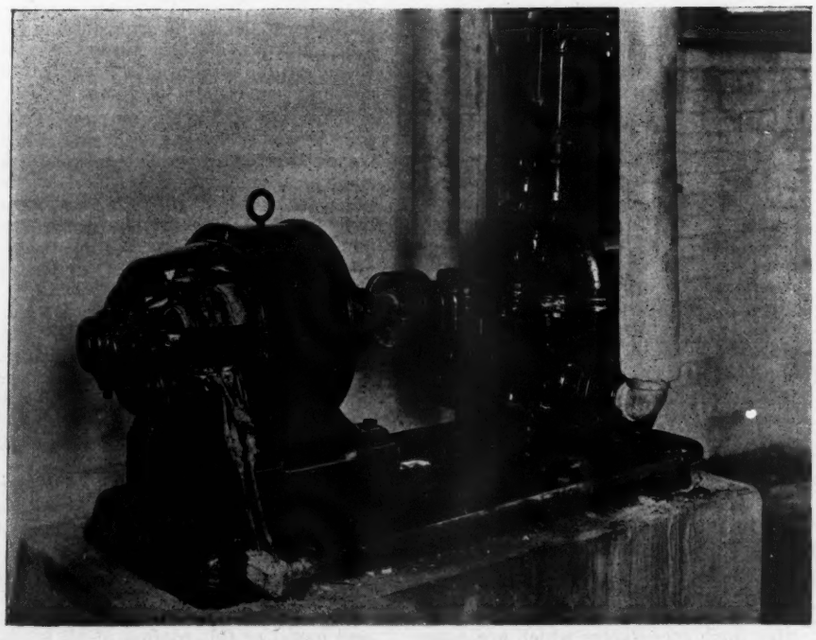
The heat loss in the 100-amp. time-lag fuse is 11 watts compared to 14.7 watts in the old fuse. These fuses were accordingly put into the clips. As a result the temperature in the panel case was so reduced that the covers could be replaced. The blowing of fuses ceased and no further trouble has been experienced with overheating.

Before these fuses were installed, the writer made many tests and experiments to determine how they acted under different strengths of current. Later he secured from the Electrical Testing Laboratories, New York, copies of tests made on various ratings of the fuse. It was found that the tests made by the writer and those of the Electrical Testing Laboratories agreed closely. The latter tests are those shown in Table III. As seen in this table, the temperature of the new fuses is appreciably less than that of the regular type with a zinc link. This is accounted for by the fact that the new fuse has a link composed principally of copper strip.

The inverse time lag, according to the manufacturer, the Multiple Electric Products Company, New York, is accomplished by the use of three other metals. These metals, cadmium, tin and antimony, are imposed on the copper strip in the form of a bead as shown in Fig. 5. It is explained that the beads remain unchanged while normal current is flowing through the fuse. At a current greater than 110 per cent of rating the four metals begin to fuse. This causes the formation of a new alloy as the three metals mix with the copper of the strip. This alloy produced at the beads has both a lower melting point and a higher resistance than copper has alone. Consequently there is a tendency to hasten the blowing of the fuse at the points where the alloying occurs. The melting point of the new alloy is so low that little heat is transmitted to the outer casing. The time required for this fusing gives the lag which makes the fuse of special value. It has also been the author's experience and it is stated by the manufacturer of the fuse that repeated overloads do not affect the operation of the fuse. In other words, if the overloads are not carried long enough to blow the fuse, it will act on the next overload like a new fuse.

Another fact that occurred to the writer is that these fuses with a copper element will help pay for themselves on account of their low resistance loss. For the 100-amp. and 200-amp. sizes, the loss in the copper link fuse is less than 70 per cent of the loss in zinc fuses of the same ratings. For the 60-amp. fuse it is 75 per cent and for the 30-amp. it is almost 90 per cent.

**Fig. 5—Heavy current is required here to start a large column of water into motion.**



## Design of Telephone Instruments

BECAUSE it is generally so thoroughly understood that the Western Electric Company has been responsible for the greatest part of the development of telephone instruments, this fact was not mentioned in the historical frontispiece entitled "Design of Telephone Instruments" which was published in our December issue. For the benefit of those who are not familiar with the subject it should be pointed out that practically all of the developments mentioned in that frontispiece were made by men connected with the Western Electric Company and the Bell Telephone System. The only exception is in the case of the "carbon button" of Edison, which, soon after its invention, was given over to the Western Electric Company.

## A Correction in Address

THIS opportunity is taken to rectify an error in the article entitled "Bonus on Operation and Maintenance" which began on page 4 of the January, 1923, issue of INDUSTRIAL ENGINEER. The address of The Federal Rubber Company was given as Racine, Wis., whereas the correct address is Cudahy, Wis.

# Trade Literature
## *You Should Know About*

**Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of the bulletin or catalog desired, as given in these columns.**

**Russell Manufacturing Company,** 814 Bath Avenue, Niagara Falls, N. Y.—This company is distributing a pocket memorandum book which contains some additional information on the trigger-lock reversible controller finger, its use and operation.

**Homer Commutator Company,** Cleveland, Ohio—A small folder describes the Homer replacement commutators which are built to replace those supplied on original equipments. These are furnished either: (a) Complete, ready to be placed on the armature shaft; (b) refilled, where the customer furnishes the shell, or (c) assembled, that is, copper bars and mica segments are assembled, machined and bound together by wire and the customer mounts them in his own shop.

**The North American Manufacturing Company,** 5902 Carnegie Avenue, Cleveland, Ohio—The North American gas and oil burning system is described in a small folder. With this system the gas or oil is discharged directly into a low-pressure blower which supplies the air for combustion and at the same time mixes with it the oil or gas.

**A. F. Way Company, Inc.,** Hartford, Conn.—A small folder entitled "A Way for Drilling" gives a description of the various types of Way electric portable drills and bench stands.

**The Sterling Varnish Company,** Pittsburgh, Pa.—A 48-page booklet on Sterling insulating varnishes and compounds gives, under the headings of "Specifications" and "Uses," very complete and concise information on each of the varnishes manufactured by this company. The specifications include a description of the varnish, its base, solvent, specific gravity and baking time or drying period. In addition, directions are given for the care and use of varnishes, the preparation of material for varnish treatment, the application, baking, and subsequent treatment, discussions on the vacuum-pressure method of impregation and on methods of testing insulation.

**Garland Manufacturing Company,** West Pittsburgh, Pa.—This company is sending out a series of circulars describing its "Galvaduct" and "Loricated" — galvanized and enameled steel—conduits.

**The Louis Allis Company,** Milwaukee, Wis.—Bulletin 406 gives the distinguishing features of the type H. D. (heavy duty) L-A motor. Several new departures in design are incorporated in this motor. Probably the most pronounced is the special one-piece indestructible rotor winding which consists of a sheet of copper punched and formed by a special mechanical process and wrapped about the rotor core and soldered.

**The Emerson Electric Manufacturing Company,** St. Louis, Mo.—Bulletin No. 3,180 describes the Type IR repulsion-start, single-phase induction motor of 1/10 to 2 hp., with special provision for overload starting duty. Diagrams and specifications for each of the types and sizes, as well as the characteristics of this motor, are included.

**Allis-Chalmers Manufacturing Company,** Milwaukee, Wis.—Bulletin 140, entitled "Electrically Driven Saw Mills," contains a number of descriptions and illustrations of electrical installations in saw mills.

**Sewickley Electric Manufacturing Company,** Sewickley, Pa.—Bulletin 20 on the "Semco" watthour meter, Model I, gives the mechanical construction, adjustment, performance characteristics, capacities, connections and dimensions for the "Semco" single-phase watthour meter. Connections for checking meters are also shown.

**Belden Manufacturing Company,** 4625 West Van Buren Street, Chicago, Ill.—A 16-page booklet on "Beldenamel" magnet wire, entitled "Useful Hints for the Engineer and Purchasing Agent," describes the manufacture, methods of testing, uses, care in handling, winding, impregnating with varnish, care in baking, and a discussion on varnishes which are injurious to Beldenamel windings.

**Brascolite Company,** 2615-25 Washington Avenue, St. Louis, Mo.—Brascolite fixtures and reflectors for use in office and factory are described in a recent catalog. This fixture is of the semi-indirect type.

**W. N. Best Furnace and Burner Corporation,** 11 Broadway, New York City—"Calorex" liquid fuel equipments are described in a 48-page booklet, Furnace Catalog 36. This contains a number of descriptions of stationary and portable furnace equipments using oil or tar fuel. Considerable space is devoted to the description of the portable torches and furnaces which are used for brazing, preheating and welding in repair and other work, particularly in railroad shops and shipyards.

**Reading Steel Casting Company, Inc.,** Bridgeport, Conn.—A small circular describes a new line of cast steel gate valves designed for 350 lb. working pressure, at a total temperature not exceeding 800 deg., or for 500 lb. working pressure at a total temperature below 100 deg.

**Magnus Electric Company, Inc.,** 451 Greenwich Street, New York City—Recent literature describes a line of heavy-duty plugs and single and duplex flush receptacles which are especially adapted for use in maintenance departments of factories and repair shops.

**Truscon Steel Company,** Pressed Steel Department, Youngstown, Ohio—The various sizes and types, together with their advantages, of pressed steel platforms for use in connection with hand and power lift trucks are given in a small folder.

**The C. O. Bartlett and Snow Company,** Cleveland, Ohio—Bulletin 49 contains a number of photographs and diagrams of typical installations of mechanical sand-handling, continuous molding and mechanical carrying equipment taken from a number of iron and steel foundries. In nearly every case the equipment has been designed and installed in buildings already constructed. In these installations the labor involved in handling sand has been reduced to a minimum.

**Brown Instrument Company,** Philadelphia, Pa.—Catalog 85, entitled "Brown Automatic Control, Signaling and Alarm Instruments," devotes 24 pages to illustrations, diagrams and explanations of the Brown method of automatic control for heating furnaces. These instruments are made for low temperature control up to 1,000 deg. F. or high temperature control to 1,300 deg. F.

**Whiting Corporation,** Harvey, Ill.—Bulletin 159, entitled "Operation and Maintenance of Whiting Electric Cranes," devotes 32 pages to comments and illustrations on the different parts of each type of crane trolley and illustrates in detail the various parts which are most likely to wear out. This simplifies the work of the maintenance department in the ordering of repair parts. Special instructions for ordering repair parts are included.

**The Battery Equipment and Supply Company,** 1458 South Michigan Avenue, Chicago, Ill.—Catalog 5 devotes 16 pages to the description of, lists and prices of the complete line of "Besco" products for battery repair.

**The Fuerst-Friedman Company,** 1251 West Third Street, Cleveland, Ohio—Bulletin 25 lists the guaranteed rebuilt and new electric motors, generators, drills, compensators and other electrical equipment on hand.

**The Canton Art Metal Company,** Canton, Ohio—A 32-page catalog illustrates the special sheet-metal work such as tote boxes, chip pans, waste pans, tool cabinets, shop stands, gear guards, tanks, hoods, heating ducts, dust collectors, shelves, tool boxes, and other sheet metal work made by this company.

**Burke Electric Company,** Erie, Pa.—Bulletin 166 describes the type WA direct-current motors and generators. These motors and generators are made with rails and pulleys, with special belt-tightening sub-bases, and may be had with perforated enclosing covers, or full enclosed.

**Mineral Oil Paint Company,** Detroit, Mich.—A small folder describes the G. & B. mineral oil paint which, it is claimed, is an anti-corrosive, heat-resisting, acid-fume and damp-proof paint for bridges, viaducts, piping, structural iron and steel, concrete and metal or felt roofing of all kinds.